AP-Q80/C

AKAI SERVICE MANUAL

FULL-AUTO QUARTZ SYNTHESIZER TURNTABLE

MODEL AP-Q80/C

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MODEL AP-Q80/C

THIS MANUAL IS ALSO APPLICABLE TO BLACK PANEL MODEL

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SECTION 1

SERVICE MANUAL

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For basic adjustments, measuring methods, and operating principles, refer to GENERAL TECHNICAL MANUAL.

I . TECHNICAL DATA

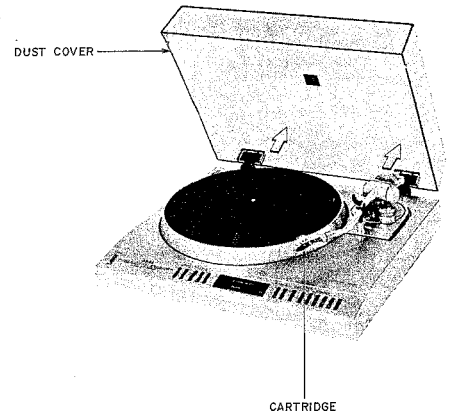
TURNTABLE	Aluminum alloy diecast Quartz Synthesizer Direct Drive
DRIVE SYSTEM AND MECHANISM	Fully Automatic
MOTOR	DC Servo Motor and DC Moter for Tone Arm Drive
SPEED CONTROL	33 1/3, 45 rpm
PITCH CONTROL	±3% Quartz Synthesizer controlled
WOW & FLUTTER	0.035% (DIN), 0.025% (JIS)
RUMBLE	46 dB (DIN A), 74 dB (DIN B), 54 dB (JIS)
SPEED DEVIATION	Less than ±0.002%
TONE ARM	Dynamic balanced type
EFFECTIVE ARM LENGTH	220 mm
STYLUS PRESSURE ADJUSTMENT RANGE	0 to 2.5 grams
APPLICABLE CARTRIDGE WEIGHT	6 to 14 grams (incl. shell weight)
ARM LIFTER	Oil damped
OVERHANG	15 mm
OFFSET ANGLE	22° 30′
HORIZONTAL TRACKING ERROR ANGLE	+3°5′, –1°13′
CARTRIDGE	MM Type (Ortofon LMB–12) (Model AP–Q80 does not include cartridge)
OUTPUT VOLTAGE	4.3 mV (DIN 45541)
CHANNEL SEPARATION	More than 28 dB (DIN 45541)
OPTIMAL STYLUS PRESSURE	1.5 grams
STATIC VERTICAL COMPLIANCE	30×10^{-6} cm/dyn
STATIC HORIZONTAL COMPLIANCE	30×10^{-6} cm/dyn
ANTI–SKATING ADJUSTER	Magnet Force Type
POWER REQUIREMENTS	100 V, 50/60Hz JPN 120 V, 60 Hz for Canada and USA 220 V, 50 Hz for Europe except UK 240 V, 50 Hz for UK and Australia 110–120V/220–240V, 50/60 Hz for the other countries
POWER CONSUMPTION	15W
DIMENSIONS	440 (W) x 140 (H) x 400 (D) (17.3 x 5.5 x 15.8 inches)
WEIGHT	10 kg (22 lbs)

* For improvement purposes, specifications and design are subject to change without notice.

II. DISMANTLING OF UNIT

In case of trouble, etc. necessitating dismantling, please dismantle in the order shown in the photographs. Reassemble in reverse order.

1



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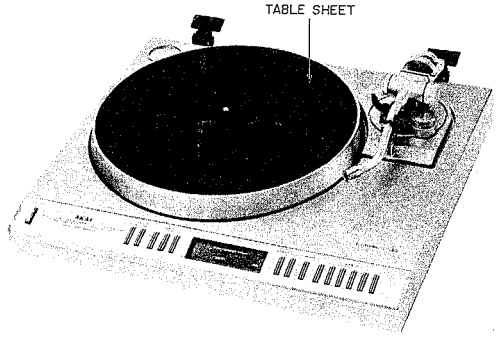

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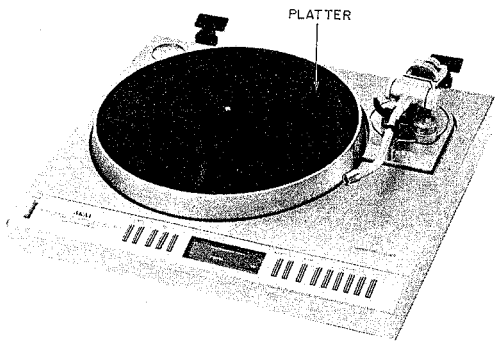

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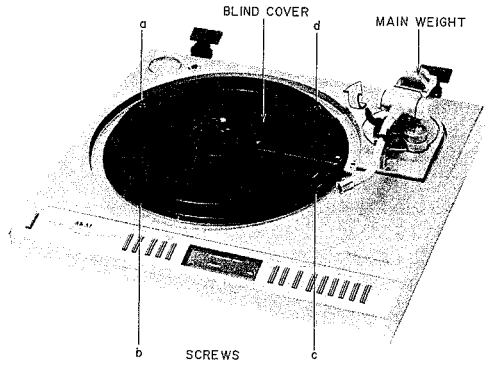

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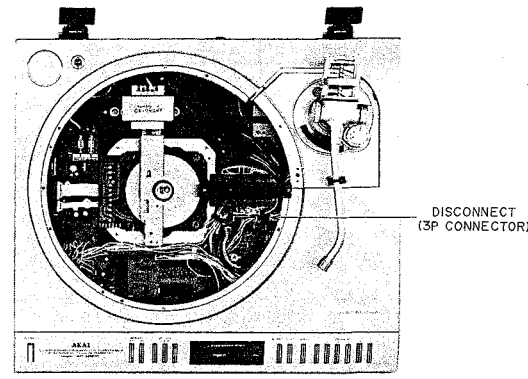

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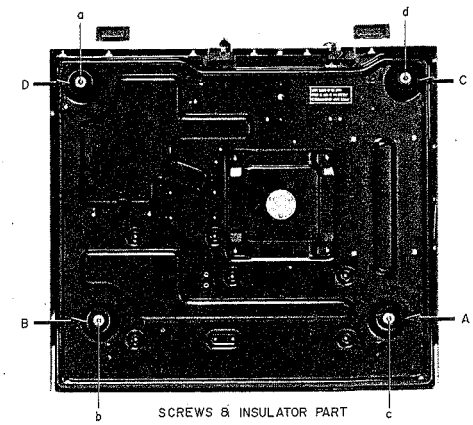
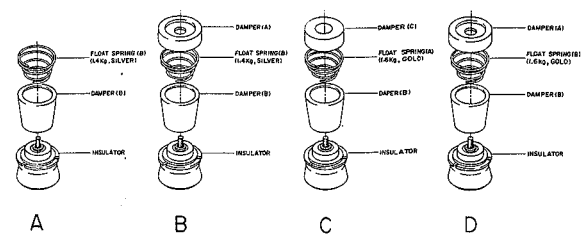
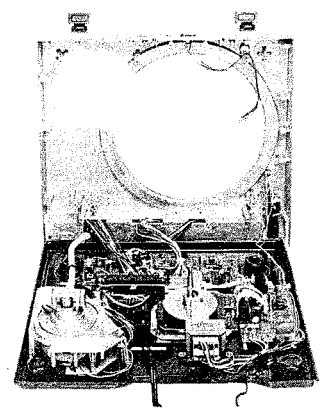




NOTE: To level and the turntable, the strength and arrangement of the insulator blocks differ. Instaill the insulator blocks as shown in the figure.

7



III. CONTROLS

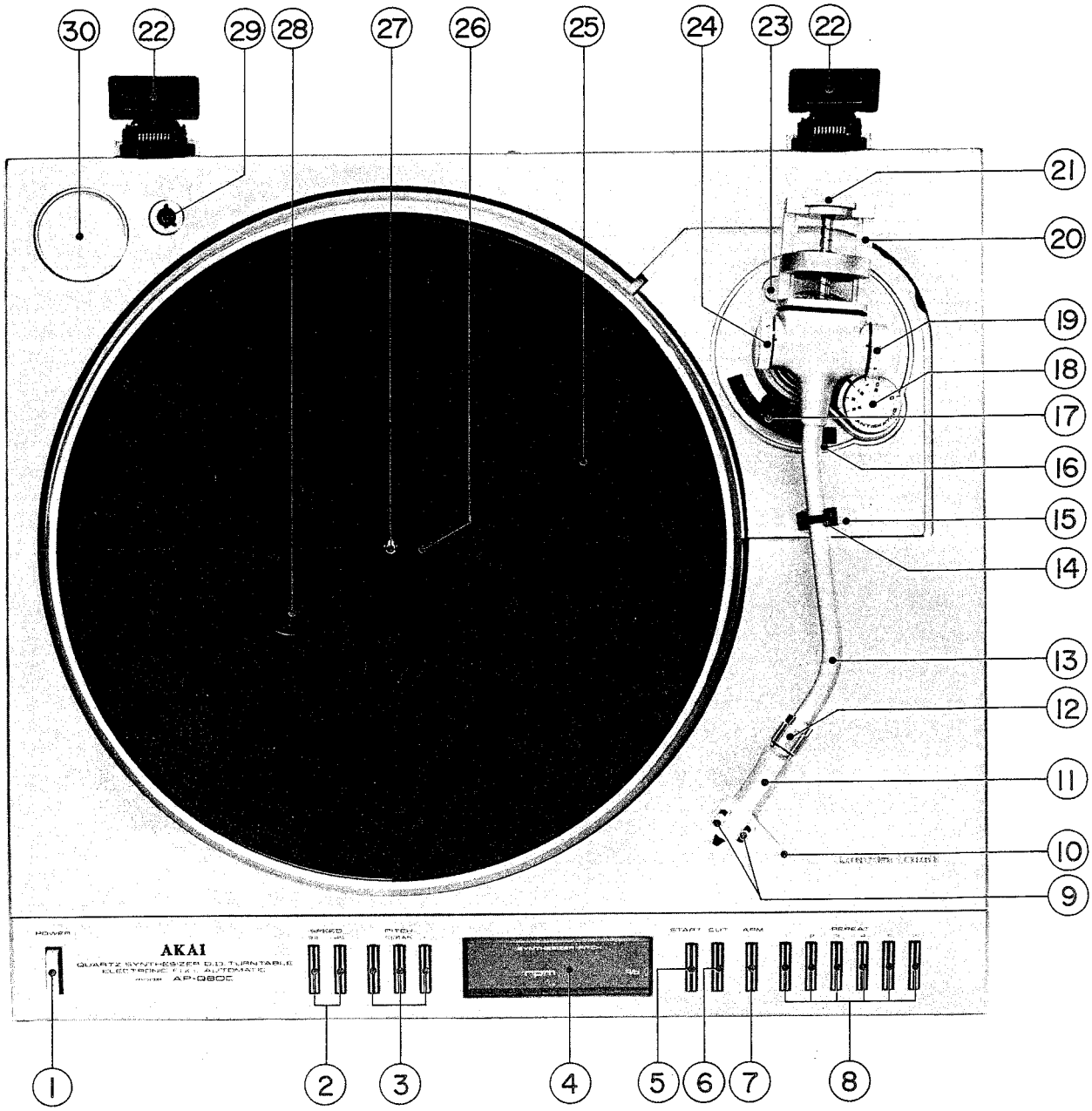


Fig. 1 Controls

1. POWER SWITCH
2. SPEED SELECTOR KEYS
3. PITCH CONTROL KEYS
4. DIGITAL SPEED/QUARTZ SYNTHESIZER PITCH CONTROL DISPLAY
5. START KEY AND INDICATOR
6. RETURN KEY
7. ARM LIFTER KEY
8. REPEAT KEYS AND INDICATORS
9. CARTRIDGE RE–SETTING SCREWS
10. CARTRIDGE SHELL FINGER LEVER
11. CARTRIDGE SHELL
12. LOCKING NUT
13. TONE ARM
14. TONE ARM REST AND LOCK
15. TONE ARM REST HEIGHT AKJUSTMENT SCREW
16. TONE ARM LIFTER ELEVATION ADJUSTMENT SCREW
17. TONE ARM LIFTER
18. ANTISKATING ADJUSTER
19. STYLUS PRESSURE ADJUSTER
20. MAIN WEIGHT ASSEMBLY
21. MAIN WEIGHT ADJUSTMENT KNOB
22. HINGERS (FOR DUST COVER)
23. LEAD–IN ADJUSTMENT SCREW CAP
24. MAIN WEIGHT ASSEMBLY LOCK KNOB
25. RUBBER MAT
26. OVERHANG ADJUSTMENT GROOVE
27. SPINDLE
28. TURNTABLE PLATTER
29. CARTRIDGE SHELL HOLDER
30. 45 rpm ADAPTER HOLDER

IV. PRINCIPAL PARTS LOCATION

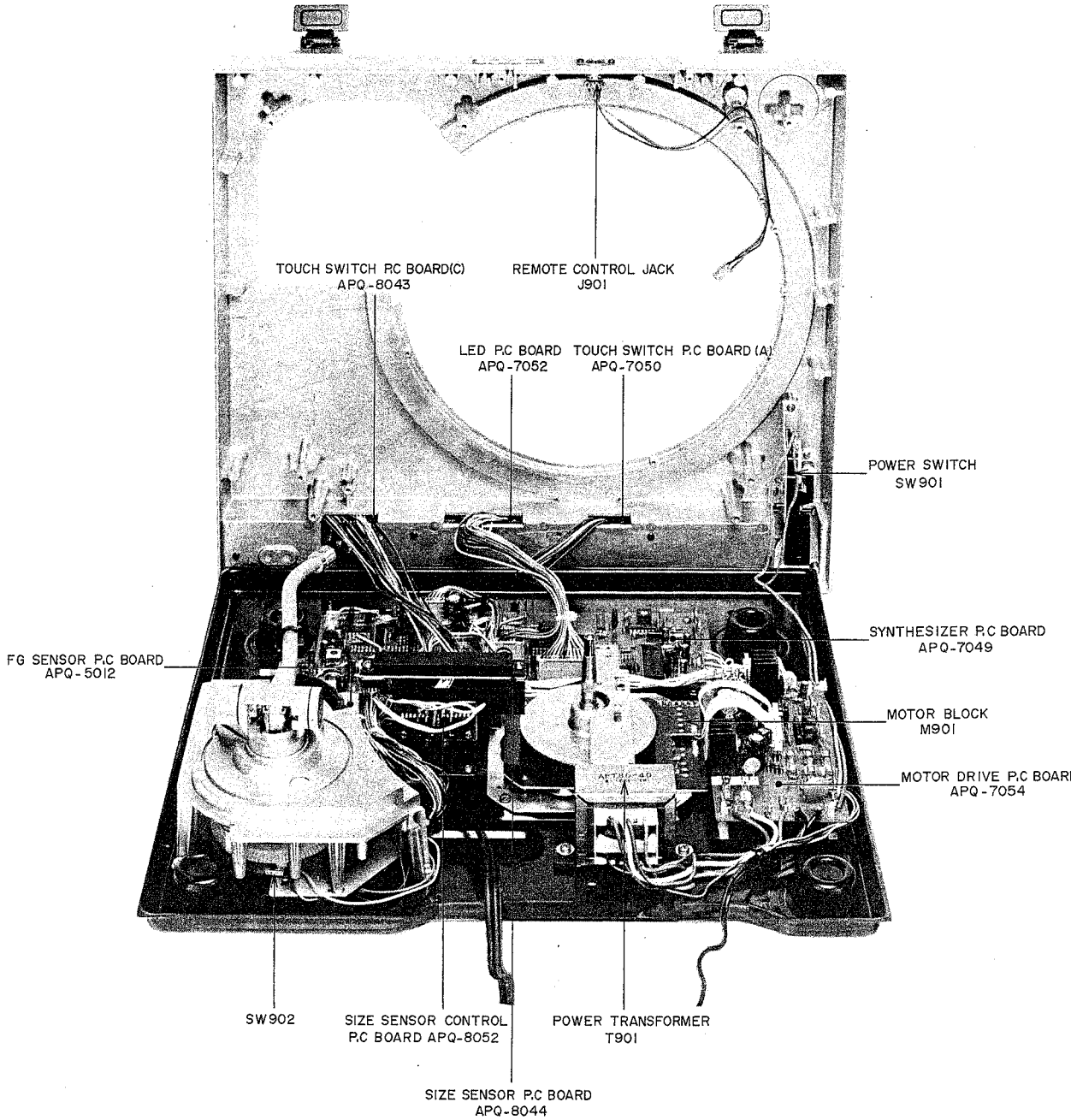


Fig. 2

V. VOLTAGE CONVERSION

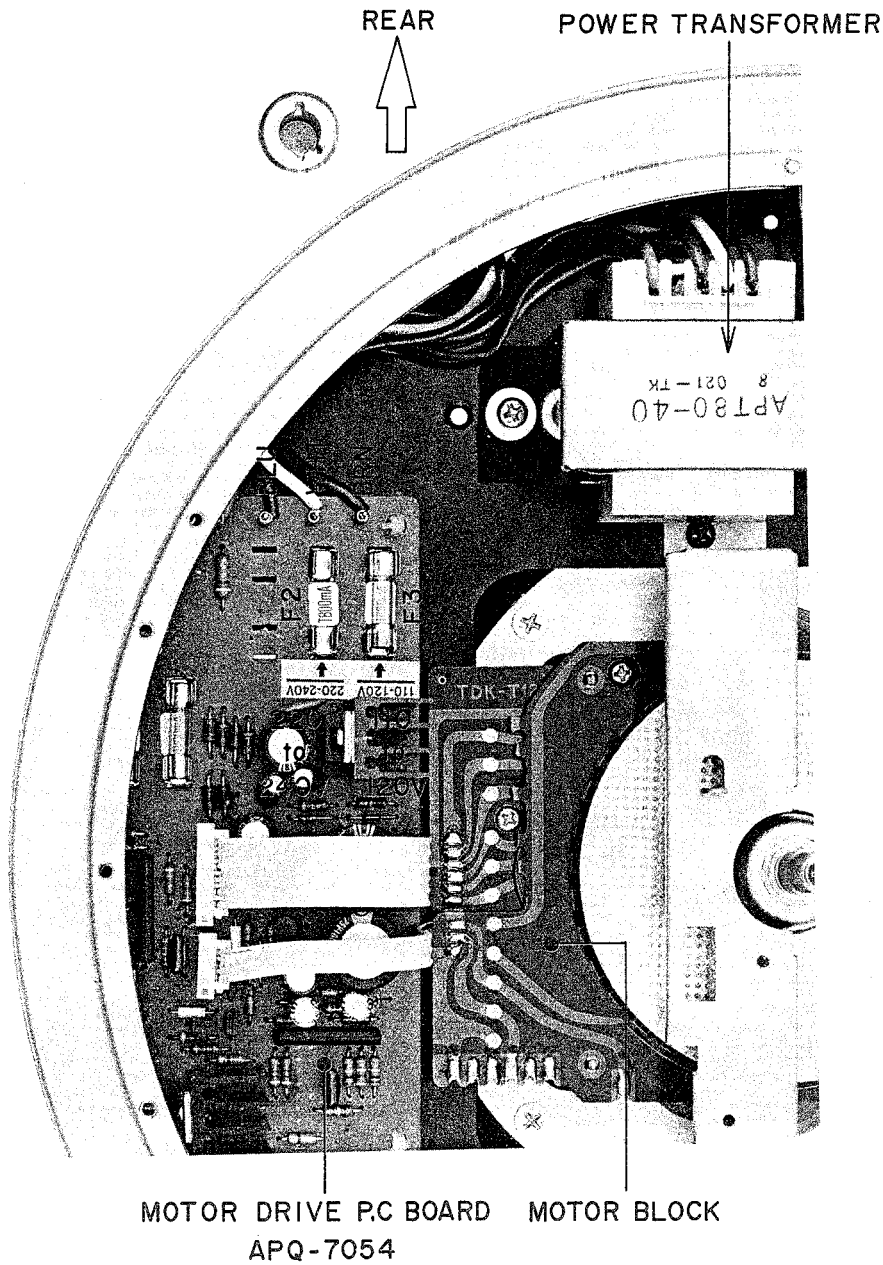


Fig. 3 Voltage Conversion (U/T Model only)

1. U/T Model (Refer to Fig. 3)

This unit can be set to 110–120 or 220–240V as required. Each machine is preset at the factory according to its destination. However, if voltage conversion is necessary, it is accomplished as follows:

1. Disconnect power cord from mains supply.
2. Loosen holding screws and remove the motor cover.
3. Remove existing Line Voltage Fuse and insert required line Voltage Fuse in the proper fuse holder.
   - F3: 110V to 120V T800 mA
   - F2: 220V to 240V T800 mA

2. Models other than U/T

No voltage conversion.

VI. BLOCK DIAGRAM

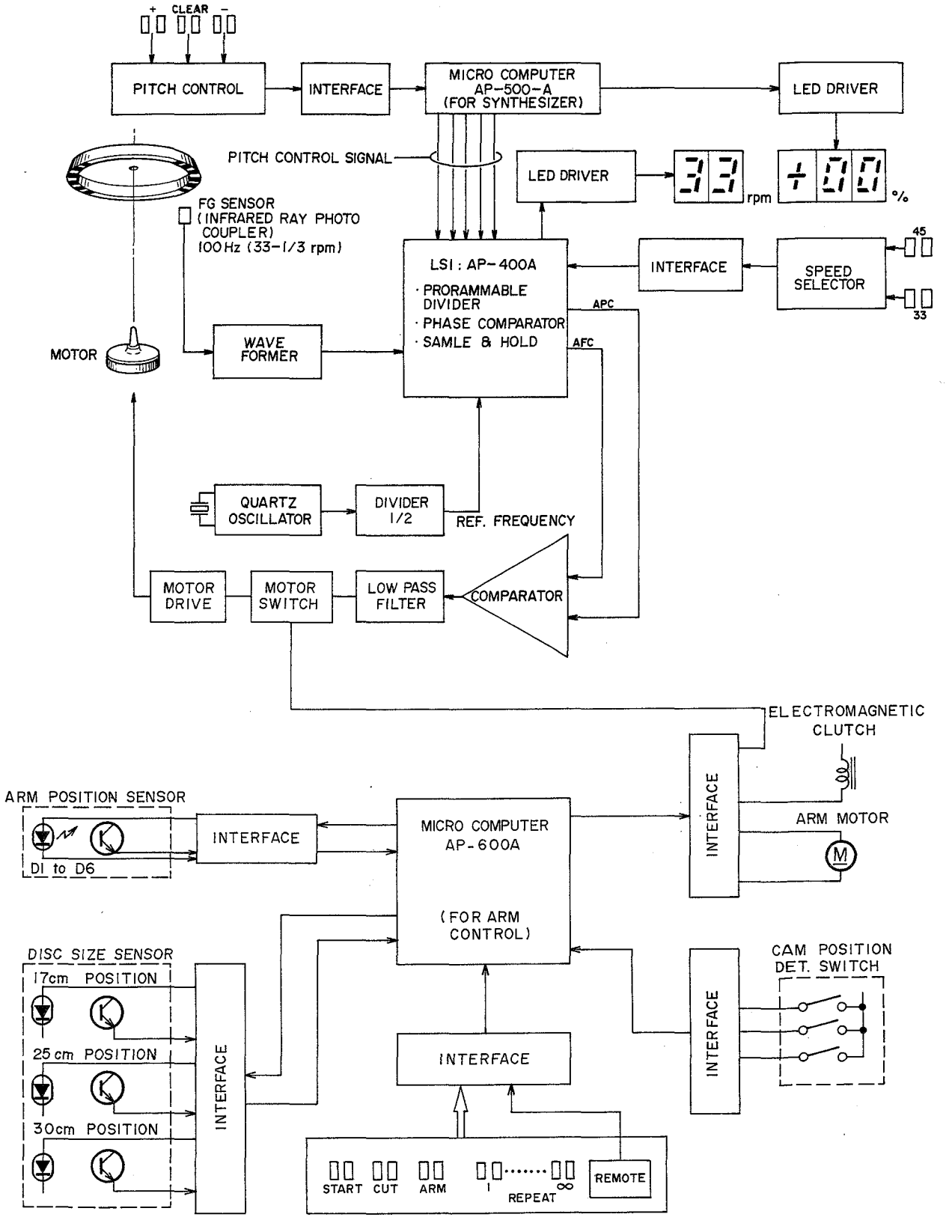


Fig. 4 Block Diagram

VII. EXPLANATION OF HOW THE COMPUTER WORKS

1. AP-500-A

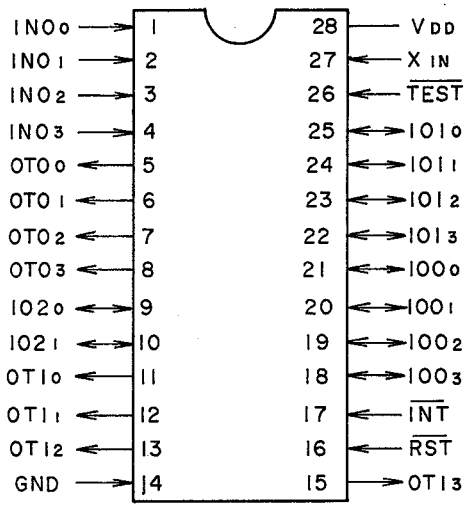


Fig. 5 Pin Configuration

Pin No.	Pin Name	Function
1	$IN0_0$	(LSB)
2	$IN0_1$	INPUT PORT 0
3	$IN0_2$	4 bit parallel input
4	$IN0_3$	(MSB)
5	$OT0_0$	(LSB)
6	$OT0_1$	OUTPUT PORT 0
7	$OT0_2$	4-bit parallel output
8	$OT0_3$	(MSB)
9	$IO2_0$	(LSB) INPUT/OUTPUT PORT 2
10	$IO2_1$	(MSB) 2-bit parallel input/output
11	$OT1_0$	(LSB)
12	$OT1_1$	OUTPUT PORT 1 4-bit parallel ouput
13	$OT1_2$	combined with 15 pin
14	GND	Ground (0V)

Pin No.	Pin Name	Function
28	V_{DD}	Power Supply (5V)
27	X_{IN}	Clock input
26	$\overline{TEST}$	Test terminal
25	$IO1_0$	(LSB)
24	$IO1_1$	INPUT/OUTPUT PORT 1
23	$IO1_2$	4-bit parallel input/output
22	$IO1_3$	(MSB)
21	$IO0_0$	(LSB)
20	$IO0_1$	INPUT/OUTPUT PORT 0
19	$IO0_2$	4-bit parallel input/output
18	$IO0_3$	(MSB)
17	$\overline{INT}$	Interrupt request
16	$\overline{RST}$	Reset terminal
15	$OT1_3$	(HSB)

Chart 1

1) Touch Switch Sensor and Indicator

The IC1, AP-500-A on the synthesizer p.c board plays the central role in sensing and displaying the states of the touch switches.

AP-500-A is a 4-bit microprocessor operating with 35 instructions, to sense and evaluate the states of the touch switches; display rpm and pitch data; and feed these data to the PLL LSI (AP-400-A) which controls the drive system.

Fig. 5 is the block diagram of AP-500-A, which has① input terminal,② output ports, and③ input/ output ports. AP-500-A receives and processes data coming through the input ports and delivers appropriate information to the output ports based on the programs stored in its ROM (read only memory) and assisted by the registers and the RAM (random access memory).

The input and output ports are connected with swiches and LEDs via interfaces. Execution of the programs proceeds, synthronized by a clock pulse, in a sequence which follows POWER ON RESET or by the regular timer insertions.

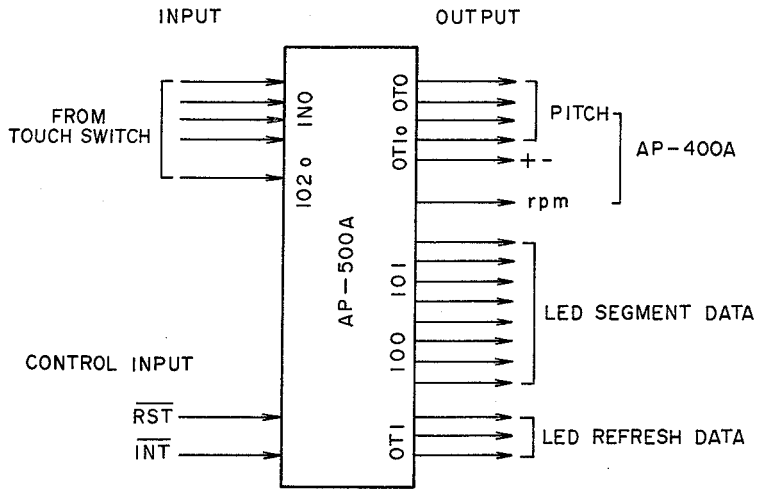


Fig. 6

*Operation of AP-500-A

Four bits of input port 0 and one bit of input/output port 2, i.e. five bits in total, are assigned to input. The other ports are all assigned to output. The output ports are latched so that data fed out are kept stored until new settings occur. Fig. 6 shows input/output connections.

AP-500-A operates under the control of the programs stored in ROM, which are a main program and an interrupt processing program. The main program is started by POWER ON RESET and the interrupt processing program is prompted by timer insertions caused by hardware, connected to terminal INT, at regularly intervals of appr. once every 4 msec. Figs. 7 and 8 are flowcharts of the main and interrupt processing program.

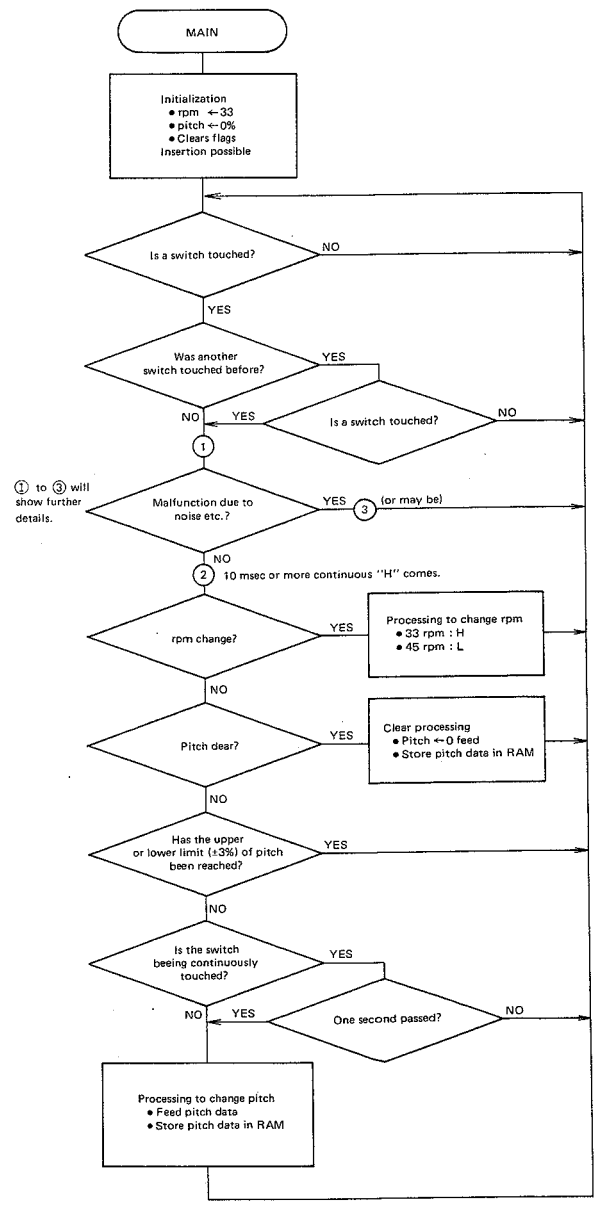


Fig. 7

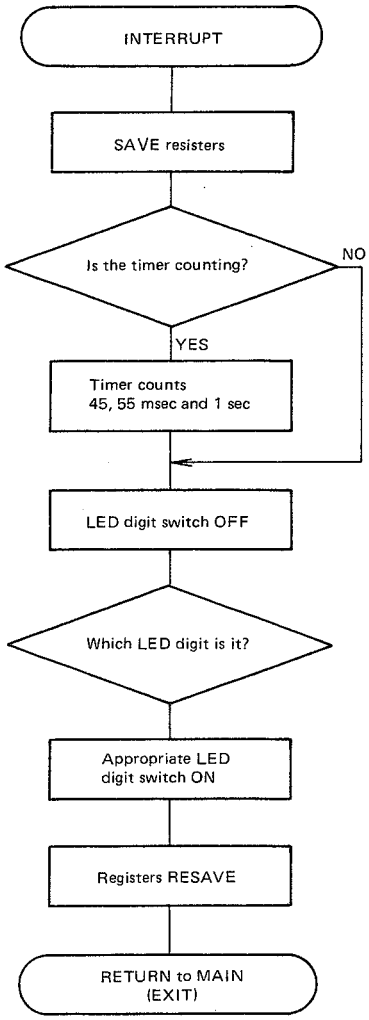


Fig. 8 Interrupt Routine

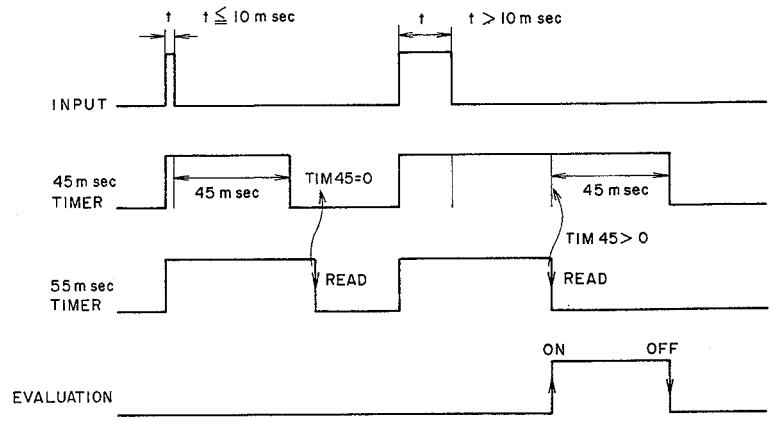


Fig. 9 Touch Evaluation

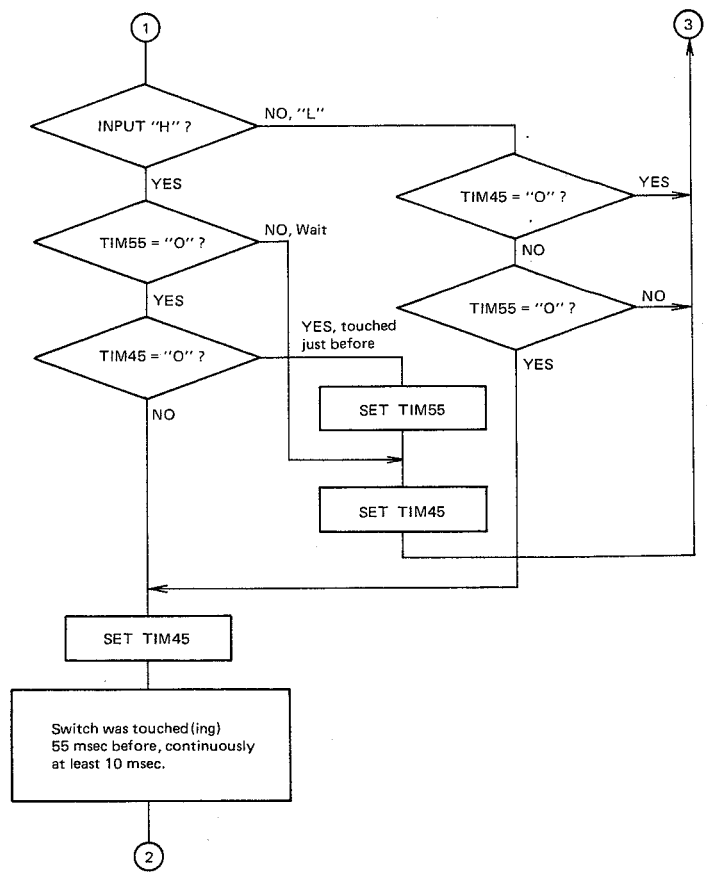


Fig. 10 Flow Chart of Touch Switch Evaluation

By the procedure described above, modified data of pitch and rpm are sent to the output ports.
Pitch data are sent as a 4-bit binary number (0000 (0) ~ 1111 (15)) to pins ⑧ through ⑪ of AP-400-A via port OT0. A minus flag ("H" when minus) is sent to pin ⑫ from port OT1. Chart 2 shows the relations between pitch and binary data. The output data are latched until the arrival of new data, and they can be checked using a tester.

Pin \ Pitch %	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
⑤ (LSB)	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
⑥	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
⑦	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
⑧ (MSB)	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
⑪	plus 0, minus 1															

Chart 2

1) –1 Main Program
When turning on the POWER switch, due to the time constant delay R33/C17 in the power supply mounted on the MOTOR DRIVE PCB (printed circuit board) the voltage at the RST terminals rises delayed from V_{DD}. Because of this RESET reaches the L level so that the main program starts by RESET JUMP.
The main program initializes the parameters of rpm and pitch and sets up the input and output ports, and then enters an endless loop in which it senses and evaluates the states of the touch switches during insertion, and feeds data about pitch etc. to the output ports.
Detection and evaluation of the ON state of a touch swich are carried out as described below.
The high input impedance of the CMOS inverter is employed to sense the state of a touch switch. The input of IC5 is brought to H level by a high value resistor. When the finger shorts the terminals of a switch, the input terminal of the associated inverter becomes "L" and the inverted output signal (H) is fed to an input port of AP-500-A. The main program detects the "H" level in the endless loop. The touch switch has a high impedance exposed and thus is liable to noise pick up. To cope with this problem, only an "H" level which is sustained for 10 msec or more is regarded as an input signal resulting from proper touch. The "H" level which is not kept for at least 10 msec is regarded as a result of noise. This scheme prevents the circuits from operating inproperly, i.e. sensing false signals, due to hum induced the line frequency of 50 Hz (20 msec) or other pulse noises.
No input signals but CLEAR will be accepted for at least 100 msec after the occurrence of a proper touch input signal (or wighin 45 msec after switch-off).
Fig. 10 is the flowchart of detection and evaluation of input signals.

When the system detects that an input port is at the "H" level, a constant is stored in a certain portion of RAM and the timers are started (refer to the section of interrupt processing program). There are two types of timers: on (TIM45) counts in intervals of 45 msec and the other (TIM55) in intervals of 55 msec. TIM55 starts when "H" has been detected for the first time. TIM45 starts each time when "H" is detected in the loop (the cycle of the loop is very short compared with the cycle of interrupt). (TIM45 turns "0" in 45 msec after turn-off). A switch is judged turned on if the system finds TIM45 operating (TIM45 $>$ 0) after TIM55 stops (TIM55 = 0). At this time, duration of the touch on the switch must be 10 msec or more.
When a proper input signal comes in, TIM45 start again when TIM45 is not zero, no input signals but CLEAR will be accepted for 45 msec after an input turns from "H" to "L". This eliminates the effect of chattering when a switch is turned off. Fig. 9 illustrate this operation.
The main program also controls malfunction of the timers and deals with the cases when one more than one switch are touched at the same time and when the pitch switch is kept depressed. Details are not explained. Refer to the flowcharts of Figs. 7 and 8.

1) –2 Interrupt Processing Program

The waveform shown in Fig. 11 is applied to pin (17) of terminal INT from the oscillator circuit of IC6. As terminal $\overline{INT}$ falls from "H" to "L", the CPU interrupts execution of the main program and changes to the interrupt processing routine. Since the waveform applied to $\overline{INT}$ rises and falls in intervals of approximate 4 msec (250 times per second), the interrupt processing routine runs regularly in the same intervals.

The interrupt processing routine controls the timers and pitch LEDs according to the main program.

The routine reads the contents of a fixed location in RAM. If the data is not zero, the routine decreases it by one and stores the result in the same location. Fig. 12 shows the hardware and timing diagram of the pitch LED.

An interrupt cycle is divided into three periods of n, n+1, and n+2 drive the 3-digit LED display dynamically.

At the same the pitch data is which converted to the corresponding LED segment data (8 bits: 7 segments + period) is delivered to pins (18) through (25) of output ports IO1 and IO0, signal LED ON for the ground common terminals of the LEDs is sent to output port OT1.

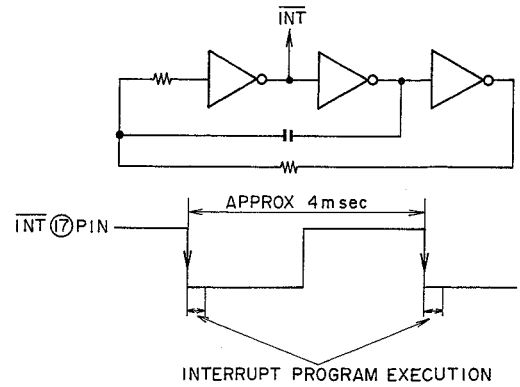


Fig. 11 $\overline{INT}$ Signal Oscillator and Waveform

At each interrupt, LED3, LED4, and LED5 are lighted in turns. Due to the high speed of the cycle, the LEDs look like being lit constantly.

When "33" or "45" is displayed (with LED1 and LED2), data of 33 = "H" and 45 = "L", which are fed out via pin (10) by the main program, and data of 33 = "L" and 45 = "H", fed via AP-400-A, switch TR 3 or TR4 to select the respective segments to be lit. At this time, signal LED ON1 at pin (12) is applied to TR5 so that the LEDs are lit only during cycle n (at the same time as LED3).

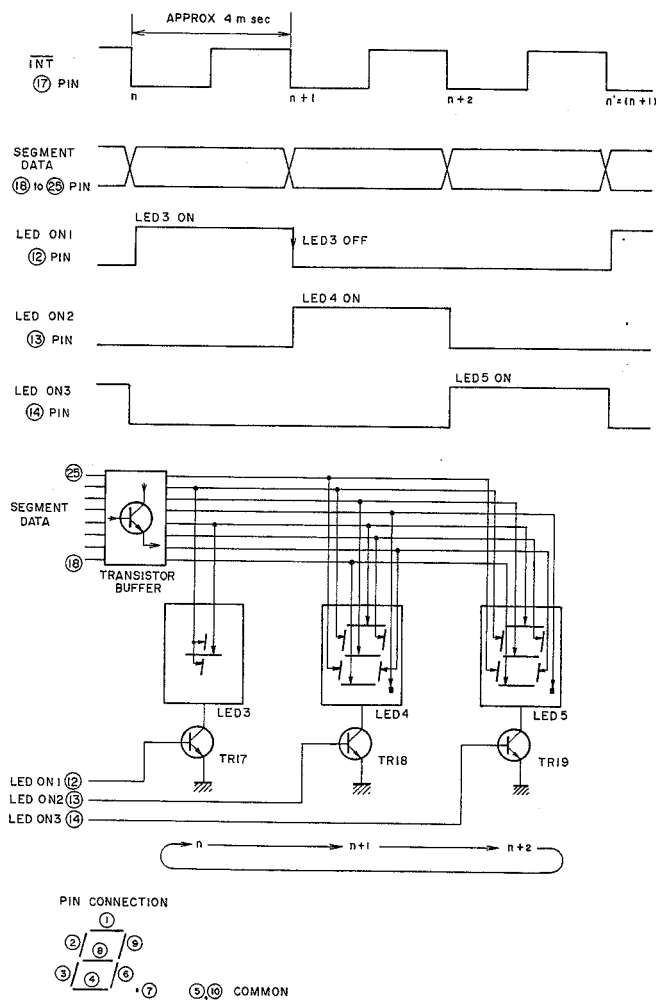


Fig. 12 Pitch LEDs Lighting Principle

2. AP-600-A

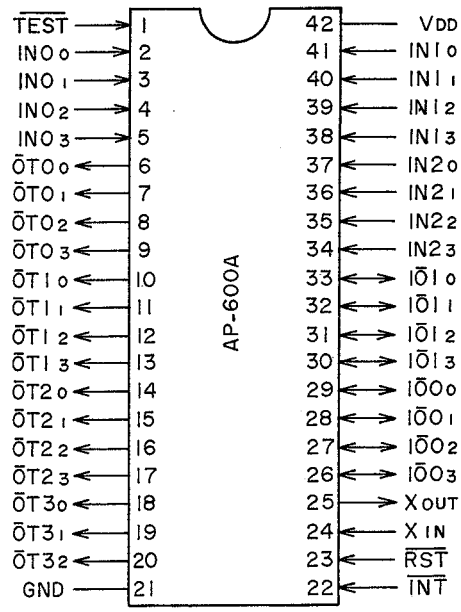


Fig. 13 Pin Configuration

Pin No.	Pin Name	Function	Pin No.	Pin Name	Function
1	$\overline{TEST}$	Test terminal	42	V_{DD}	Power supply (5V)
2	$IN0_0$	(LSB)	41	$IN1_0$	(LSB)
3	$IN0_1$	INPUT PORT 0	40	$IN1_1$	INPUT PORT 1
4	$IN0_2$		39	$IN1_2$	
5	$IN0_3$	(MSB)	38	$IN1_3$	(MSB)
6	$\bar{O}T0_0$	(LSB)	37	$IN2_0$	(LSB)
7	$\bar{O}T0_1$	OUTPUT PORT 0	36	$IN2_1$	INPUT PORT 2
8	$\bar{O}T0_2$		35	$IN2_2$	
9	$\bar{O}T0_3$	(MSB)	34	$IN2_3$	(MSB)
10	$\bar{O}T1_0$	(LSB)	33	$I\bar{O}1_0$	(LSB)
11	$\bar{O}T1_1$	OUTPUT PORT 1	32	$I\bar{O}1_1$	INPUT/OUTPUT PORT 1
12	$\bar{O}T1_2$		31	$I\bar{O}1_2$	
13	$\bar{O}T1_3$	(MSB)	30	$I\bar{O}1_3$	(MSB)
14	$OT2_0$	(LSB)	29	$I\bar{O}0_0$	(LSB)
15	$OT2_1$	OUTPUT PORT 2	28	$I\bar{O}0_1$	INPUT/OUTPUT PORT 0
16	$OT2_2$		27	$I\bar{O}0_2$	
17	$OT2_3$	(MSB)	26	$I\bar{O}0_3$	(MSB)
18	$OT3_0$	(LSB)	25	X_{OUT}	Clock output
19	$OT3_1$	OUTPUTPORT 3	24	X_{IN}	Clock input
20	$OT3_2$	(MSB)	23	$\overline{RST}$	Reset terminal
21	GND	Ground terminal	22	$\overline{INT}$	Interrupt request terminal

Chart 3

1) Introduction

The AP-600-A is a 4-bit type microcomputer with the same architecture and instructions as the AP-500-A. The only difference is in the number of input and output ports. These ports include 4 sets of output ports (OT0 ~ OT3, total 15 bits), 2 sets which may be used as either input or output ports (IO0 ~ IO1, total 8 bits) and 3 sets of input ports (IN0 ~ IN2, total 12 bits).

The AP-600-A is mainly used in controlling tonearm movement. As can be seen from the block diagram in Fig. 14, this involves detection of the disk size of the record on the turntable platter and position detection of the tonearm and tonearm drive cam. And in addition to indicator LED control on the basis of command input signals from the START, CUT, ARM and REPEAT switches, mechanism control command output signals are generated.

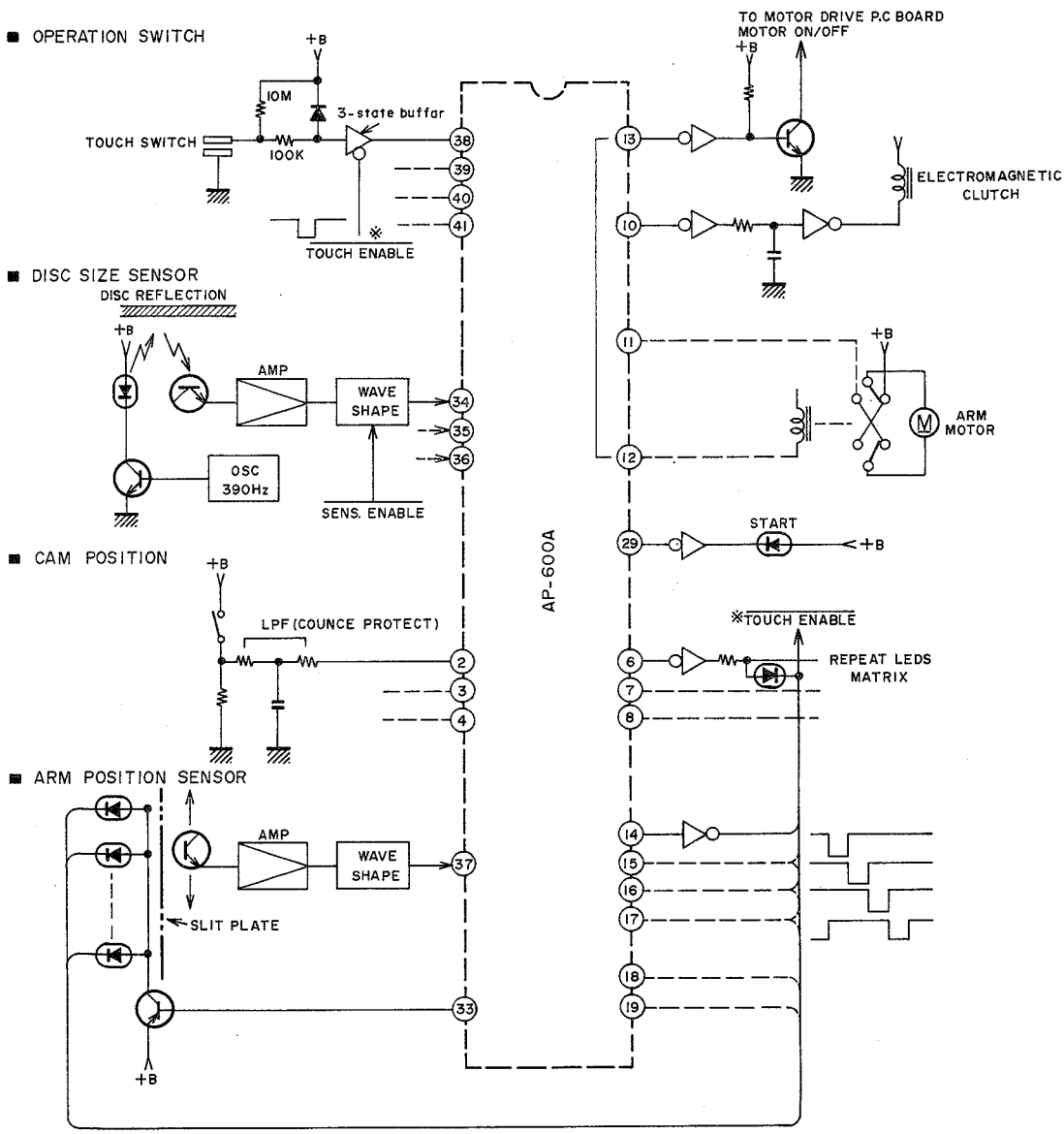


Fig. 14 Block Diagram

2) Basic Operation

All processing operations in the AP-600-A are synchronized with the clock frequency which in turn is determined by the resonance frequency of the circuit elements connected to pins (24) and (25).

The program is intially started by power-on resetting when the $\overline{RST}$ terminal (pin (23)) is set to "L" level, and the interrupt program then executed systematically every time pin (22) is set to "L" level by the connected oscillator circuit.

The input and output signals passed via the various terminal interfaces are described below.

3) Touch Switch Detection and LED Display

A general outline of the operations involved in touch switch detection and the corresponding LED display is shown in Fig. 15.

In this touch switch detection, the input stage of the C-MOS three-state buffer (or NAND) pulled up by a high resistance of about 10 Megaohms is switched to "L" level by grounding with the human hand etc. When the three-state buffer control input is at "L" level, the output reflects that input, while if the control input is switched to "H" level, the output will always be switched to high impedance.

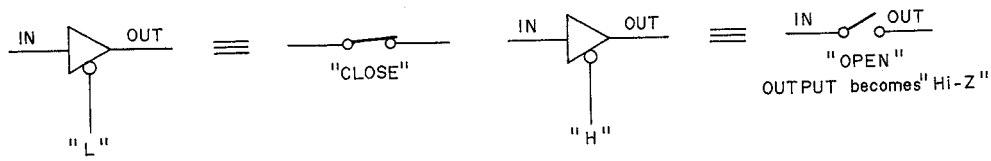


Fig. 15

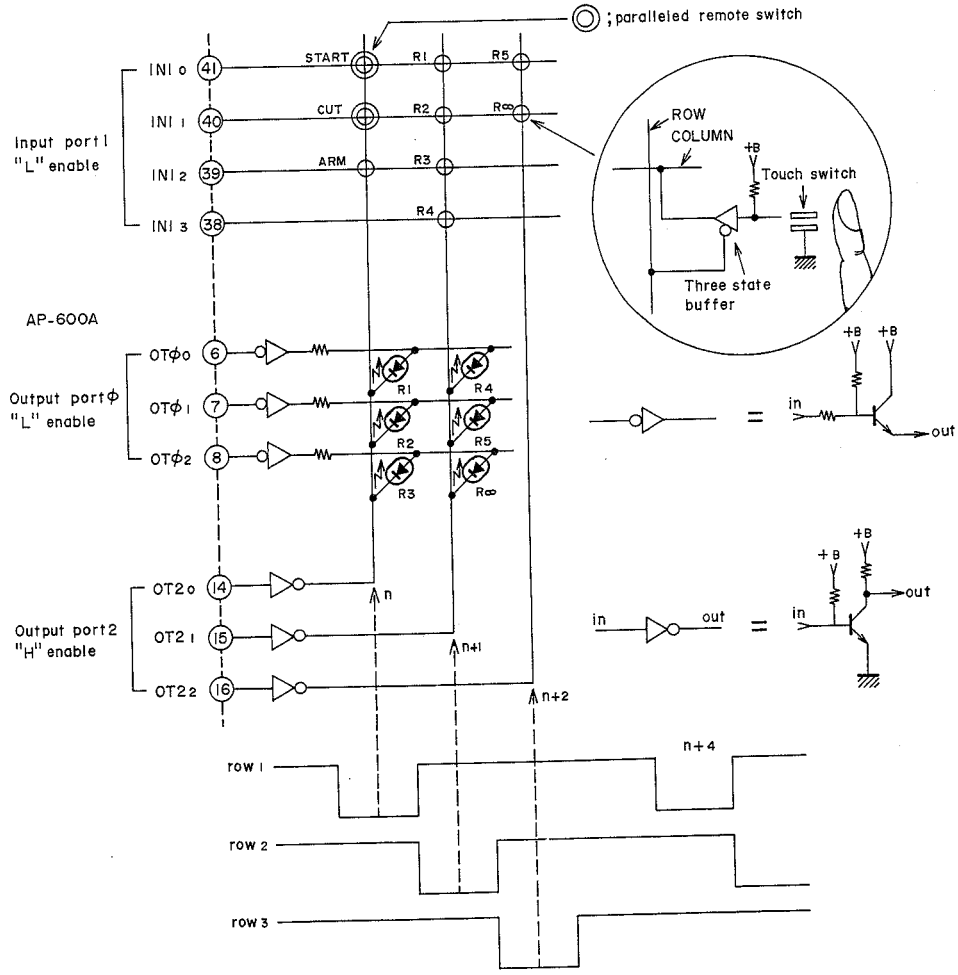


Fig. 16 Touch Switch Matrix

This circuit is made up of a matrix with the three-state buffer outputs forming the rows and the control inputs forming the columns. The CPU switches the output ports (pins ⑭ to ⑯) to "H" level in a cyclic fashion, the resultant signal being applied to the three-state buffer control inputs (row terminals) via transistor inverter.

When any one of the AP-600-A input ports (pins ㊳ to ㊶) is switched to "L" level, the CPU can tell which switch has been touched by means of the row output timing and column data.

The LED circuit which indicates START and the REPEAT number is also a matrix structure. The CPU drops the column containing the LED turned on by the input from the touch switch to "L" level when the appropriate row output appears.

4) Record Disc Size Detection

The circuitry connected to the AP-600-A input ports (pins ㉞ to ㊱) is used in disk size detection. The hardware involved in disc size detection is outlined below. Both the platter and the rubber mat include a total of 9 detections holes, 3 each along 3 radius lines and around 3 concentric circles. The holes along the radius correspond to 17cm (7in), 25cm (10in) and 30 cm (12in) records sizes. Three pairs of photo couplers with infra-red frequency response are mounted below the platter at positions corresponding to the detection holes. And only when a record is placed on the platter can the LED beam be reflected off the underneath of the record and be picked up by the accompanying photo transistor.

The LED and photo transistor are mounted slightly

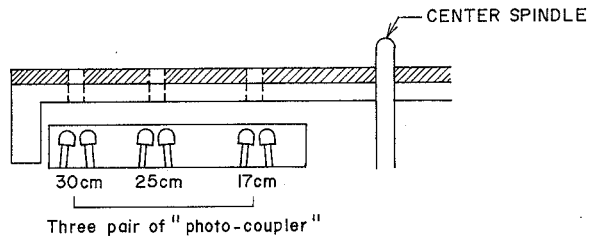


Fig. 17-A

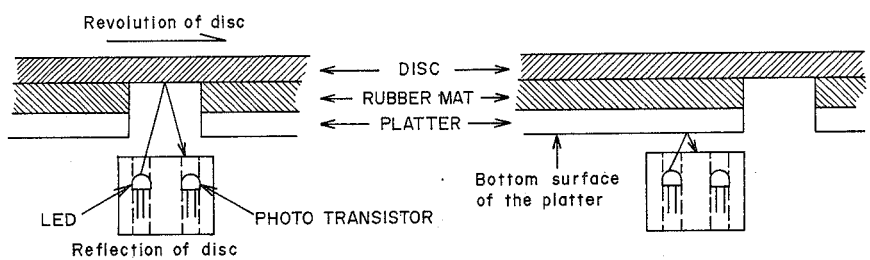


Fig. 17-B

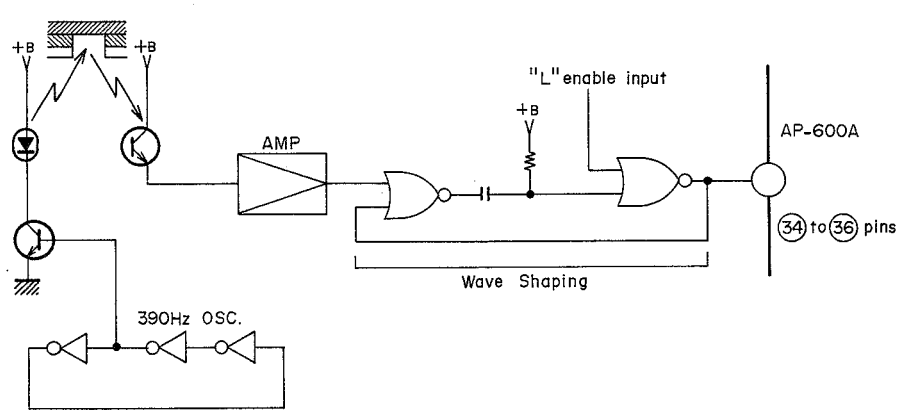


Fig. 18 Principle Diagram of the Disc Size Sensor

apart from each other so that the LED beam reflected off the underneath of the platter will not be picked up by the photo transistor. And since the photo transistor is insensitive to visible light, it will not be activated by ordinary room light when no record has been placed on the platter.

The interface system whereby the photo transistor detection data is passed to the AP-600-A is outlined below.

The LED is driven by a 390Hz square wave of approx. 2.5msec cycle period, and if the photo-coupler is "coupled", the photo transistor also generates a similar waveform. This waveform is amplified and applied to a waveform shaping circuit made from NOR gates. The input of one of these NOR gates serves as the "L" enable control input (when this terminal is "H" level, the output will always be "L" level irrespective of what the input may be). When this control input is switched to "L", the 2.5msec (approx.) square wave is applied to pins (34) ~ (36) of AP-600-A.

The "L" enable input used to control the transfer of the detection signal to the CPU is conditioned in the following way by the circuit in the SIZE SENSOR printed circuit board. In the following diagram, the logic gate symbol has been modified in order to make the logic level easier to understand. Otherwise, the circuit is the same as the general circuit diagram. "L" level appears at terminal (4) of the SIZE SENSOR CONTROL printed circuit board when terminal (2) is switched to "L" level, and this in turn is the result of the signals from the CAM position detector switch (described later) and the AP-600-A mechanism control output (also described later) being subject to MTRON ($\overline{\text{CAMREV}}$ + CAMPLY). Generally this means that the tonearm is either on the record, or is moving from the arm rest to the lead-in groove (with the turntable motor running in both cases). (Refer to later section for further details).

In addition, the circuit at sections (A) and (B) in the same SIZE SENSOR CONTROL board utilize the C1/R1 and C2/R3 time constants to limit the time which terminal (4) stays at "L" level to about 15 ~ 20msec. This is outlined in the following diagram.

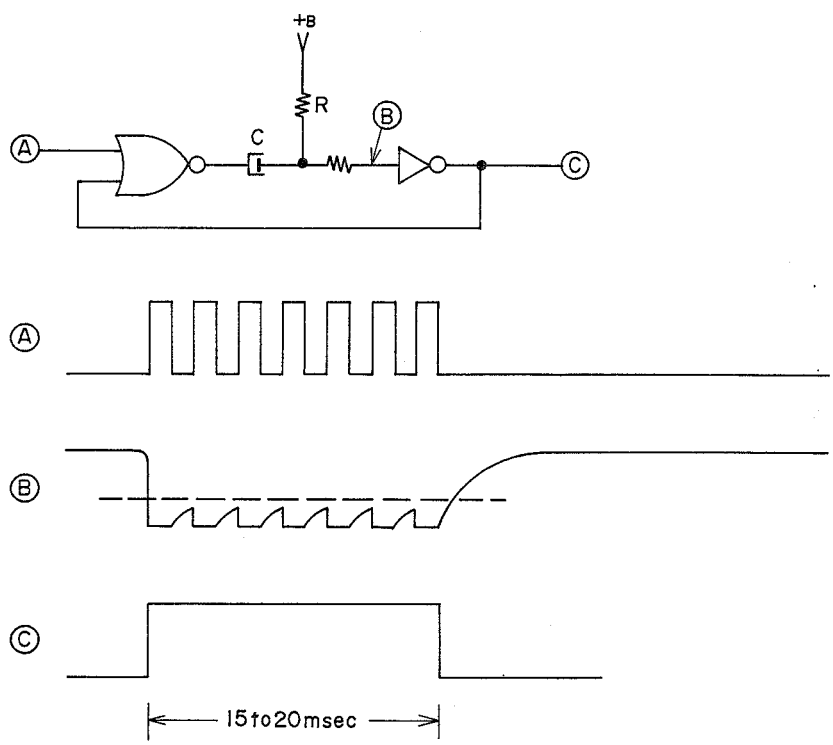


Fig. 19

Since R is a large resistance, the potential at point (B) will lag behind the potential of the charge on (C), thereby maintaining the "L" level for a little longer.

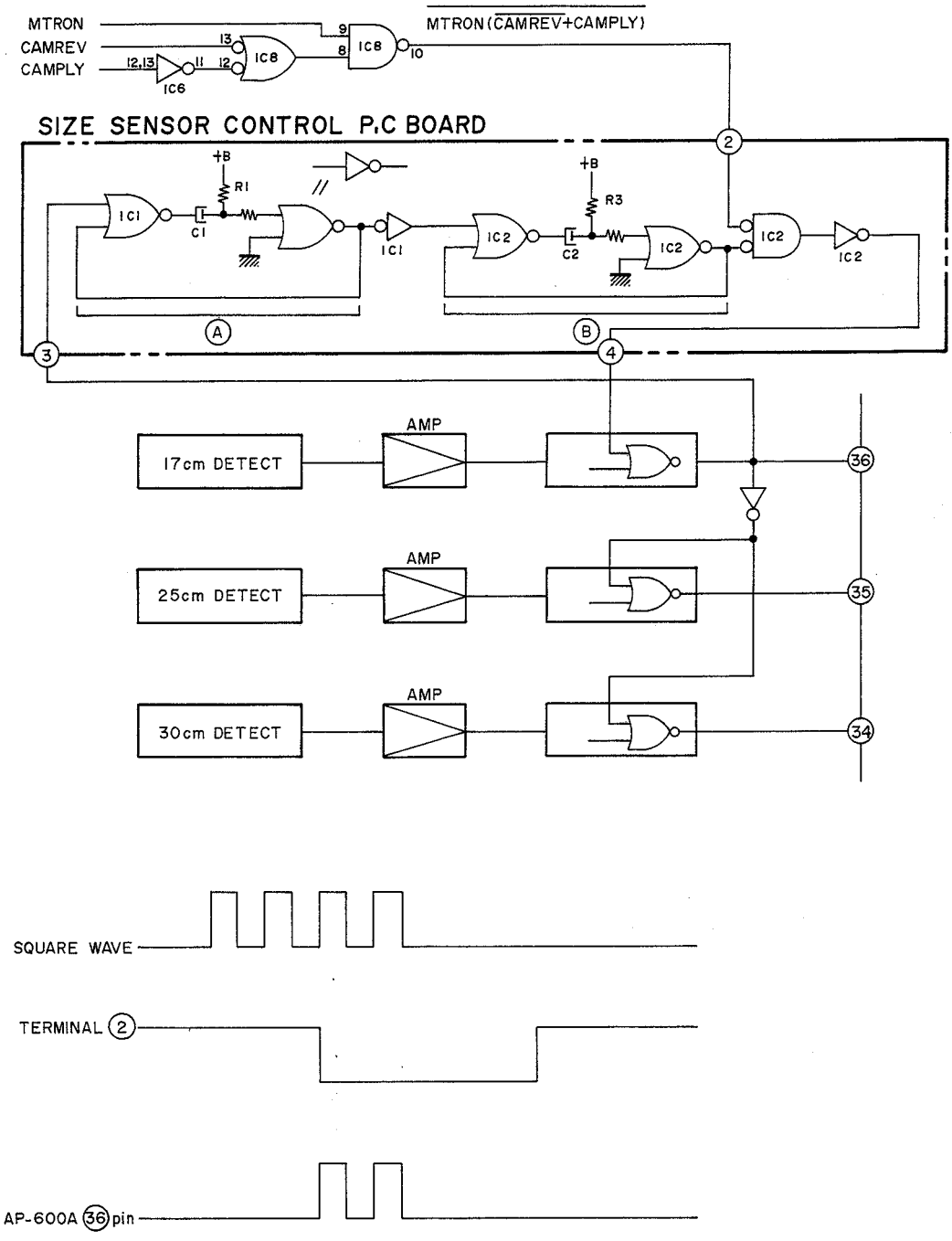


Fig. 20

Consequently, the output waveform shown in Fig. 20 below will appear at terminal (2) of the SIZE SENSOR CONTROL board, and is used in controlling the period that the detection signal is applied to the CPU. The signal applied to pin (36) of AP-600-A is inverted simultaneously and used as the enable signal for 25cm and 30cm detection purposes. This means that for detection of 25cm and 30cm disks, not only the outer circumference but also the inner circumference must also be detected.

5) Cam Position Detection

Tonearm drive is controlled by the forward/reverse rotation of a circular cam mounted in the tonearm shaft pivot. The CPU detects the position of the cam by means of 3 leaf switches mounted on the outer rim of the cam. The conditions whereby these switches are turned on and "H" level then passed to CPU input ports ② ~ ④ are outlined below.

The "H" levels generated by these switches are mainly obtained at the following times.

S904 CAMOVE Mainly during tonearm movement (except during normal play).

S902 CAMPLY When the tonearm is moving from the arm rest to the lead-in groove, and when the tonearm is lowering onto a record disk.

S905 CAMDSC Mainly while the tonearm is on the record disk (i.e. during normal play). (There is no switching to "L" level during REPEAT mode).

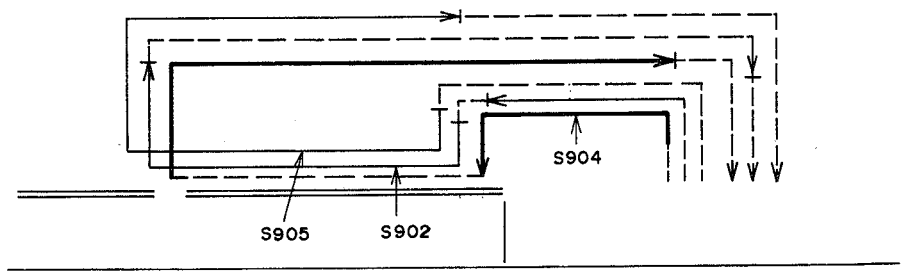


Fig. 21

6) Toneaem Position Detection

In order to check the lead-in and lead-out timing, the to tonearm position is detected separately from the cam position detection operation.

The tonearm position is detected by means of 6 LEDs mounted in the tonearm shaft pivot stage, and light beams being passed through a slit plate to a photo transistor.

The operating principles of the tonearm detection system is outlined in Fig. 22.

*Lead-in Operation

Except when the tonearm is on the record disk during normal play, the CPU sets the pin ㉝ output port to "L" level, resulting in +B being applied to the anodes of LEDs L1 ~ L4. The cathodes of these LEDs are connected to the output ports (pins ⑭ ~ ⑰) of AP-600-A via a transistor inverter.

As was described earlier under section 2, "Touch Switch Detection and LED Display", these output ports are switched to "H" level in a cyclic fashion, resulting in the LEDs (L1 ~ L4) being turned on and off repeatedly and sequentially.

When the tonearm is moved and the photo transistor is passed over one of the slits, the LED light beam is detected, and the resultant "L" level then passed to input pin ㊲ of AP-600-A. If that position corresponds with the disk size detection position, the CPU will generate a "tonearm lowering" instruction. (CAM rotation).

When the tonearm is then lowered onto the record disk, the $\overline{\text{ARMCHK}}$ terminal pin ㉝ is set to "H" level, resulting in the LEDs (L1 ~ L4) being turned off. At the same time, an output signal is passed to pin ⑱ (for 25 cm or 30cm disk) or pin ⑲ (for 17cm disk) in order to light up the LED indicating the lead-out position for the record being played.

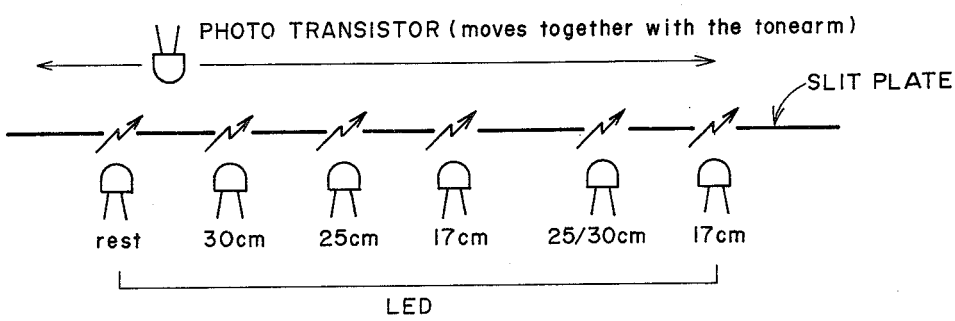


Fig. 22 Tonearm Position Sensing Principle

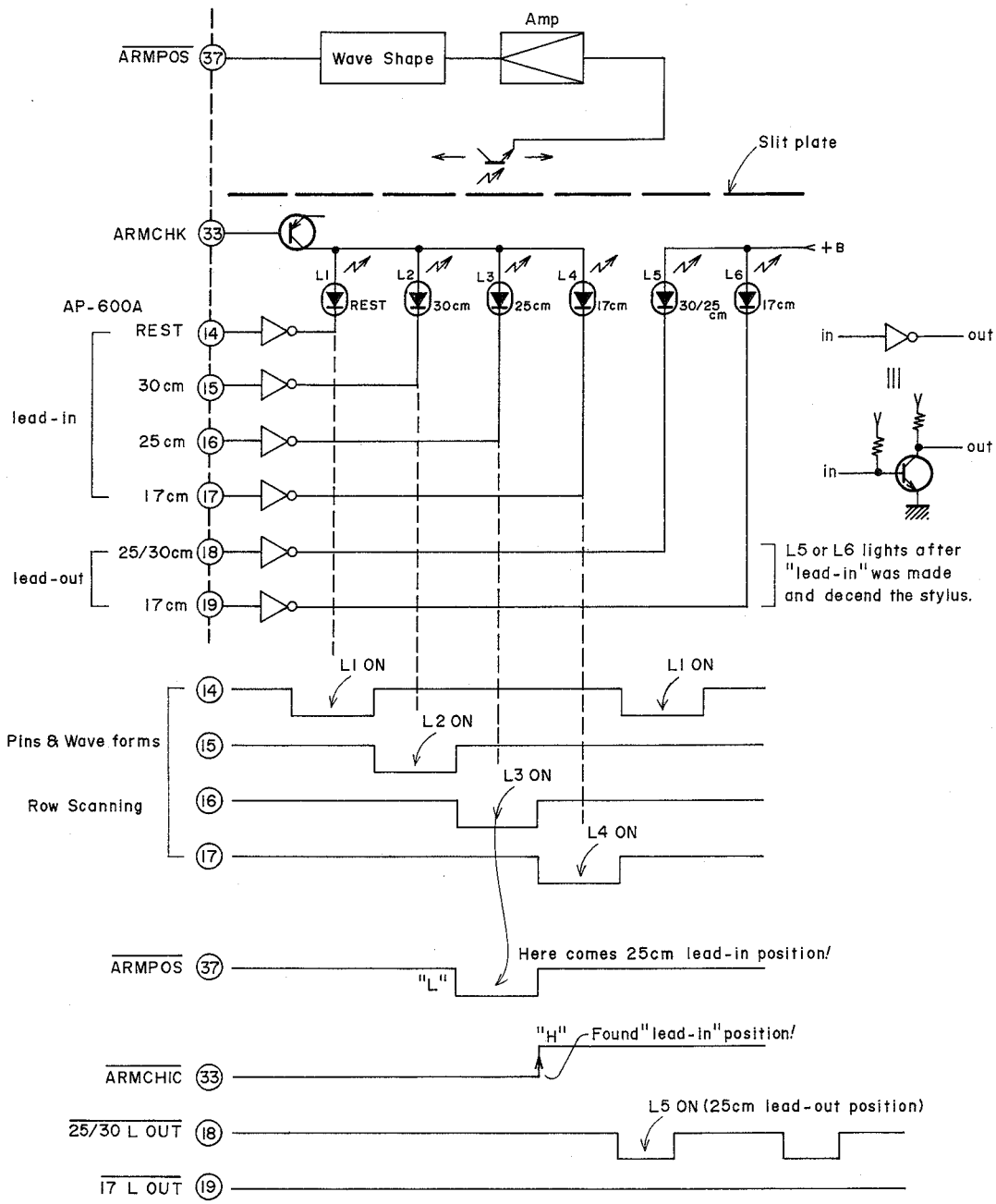


Fig. 23

*Lead-Out Operation

When the photo transistor detects a light beam from LED L5 or L6, the ARMPOS terminal pin (37) is set to "L" level in the same manner as during the lead-in operation.

One the lead-out position has been detected, the CPU switches the ARMCHK terminal pin (33) back to "L" level to turn the LEDs (L1 ~ L4) back on in readiness for repeat mode etc.

The tonearm is raised and proceeds to return to the rest position, or commence repeat mode operation.

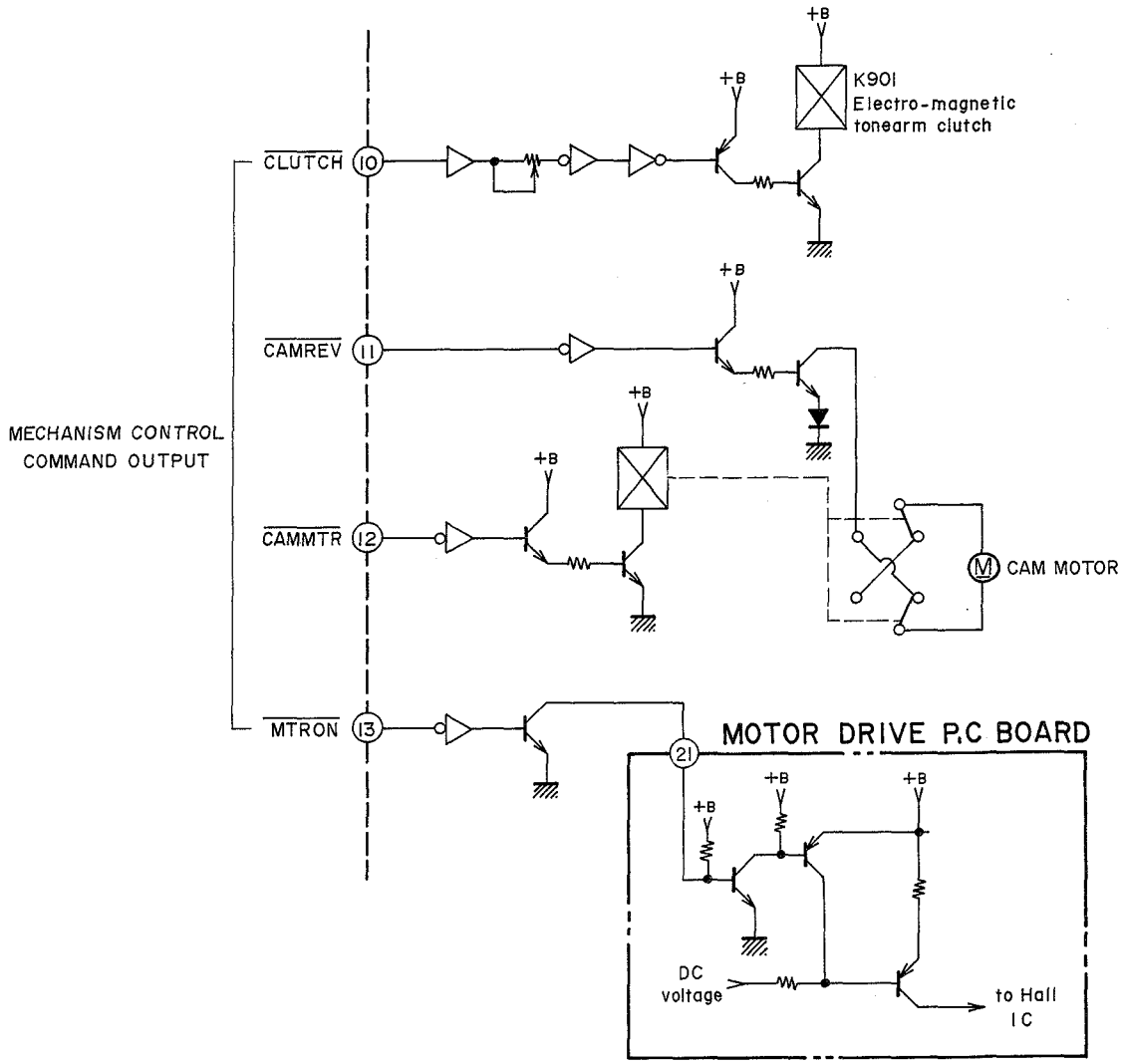


Fig. 24

7) Mechanical Control Output Signals

Disk size detection, cam position detection and tonearm position detection data is processed (evaluated and computed etc) according to the touch switch command inputs, the resultant mechanism control outputs appearing at the output ports (pins ⑩ ~ ⑬). These mechanism control output signals include the turntable motor on/off signal $\overline{\text{MTRON}}$, the cam motor on/off signal $\overline{\text{CAMMTR}}$, the cam motor reverse signal $\overline{\text{CAMREV}}$, and the tonearm/cam magnetic clutch on/off signal $\overline{\text{CLUTCH}}$.

$\overline{\text{MTRON}}$ switches the MOTOR DRIVE printed circuit board servo DC voltage on and off, while the other signals control the cam motor and magnetic clutch K901 via the interfaces.

This completes the outline of the AP-600-A and peripheral circuits. Although this outline has not included a description of the algorithms involved in controlling the microcomputer, tonearm movement together with the START, CUT, REPEAT and other command inputs can be checked during actual play of a record disk on the turntable.

VIII. EXPLANATION OF HOW THE SERVO CIRCUIT WORKS

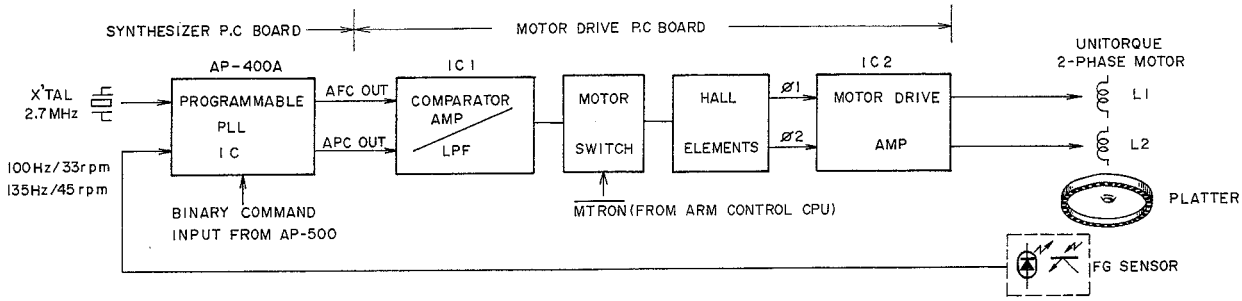


Fig. 25 Motor Servo Phase Lock Loop Diagram

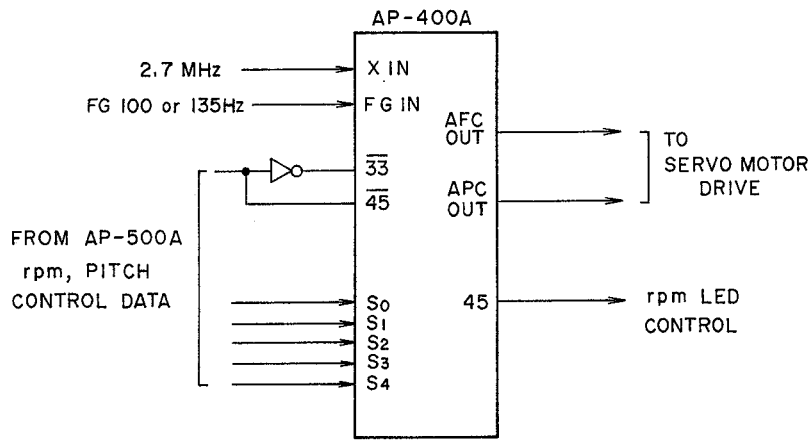


Fig. 26

Fig. 25 is the block diagram of the motor servo circuit. AP-400-A is a synthesized PLL LSI which compares a reference signal supplied by a quarts oscillator and the revolution speed signal detected by the FG sensor with reference to the rpm and pitch data (binary numbers) supplied by AP-500-A.

And it generates the voltages AFC OUT and APC OUT which are proportional to the revolution speed and the phase difference respectively.

Fig. 26 shows the input and output signals. Fig. 27 show the pin assignments and the block diagram of the LSI.

A photocoupler detects light reflected from the strobe pattern on the bottom of the platter. The FG frequency is 135 Hz at 45 rpm and 100 Hz at 33-1/3 rpm.

The reference frequency is 2.7 MHz which is generated by dividing the base frequency of 5.4 MHz by two.

Rpm is selected by making terminals 33IN or 45IN at "L".

For pitch control, the 4-bit binary number of S0(LSB) to S3 (MSB), with a minus flag set up in S4, determines pitch in the range of 0% to 3% in steps of 0.2%. For details, see Chart 2 in Section 1 of Part VII Explanation of How the computer works, "Touch switch sensor and indicator".

APC OUT and AFC OUT are obtained by sampling and holding momentary values of a sawtooth wave which is generated by integrating a square wave with an external capacitor. The peak level of the sawtooth wave is proportional to the DC voltages applied to pins ⑯ and ㉒. APC OUT and AFC OUT are applied to the comparator-amplifier of IC1 on the motor drive PCB and then applied to the base of TR1, via a low-pass filter, to control the collector current. This current is applied to a Hall element, ensuring that the output current of 2-phase motor drive amplifier IC2 is also proportional to it.

The motor drive amplifier IC2 is designed to have a frequency response which falls at low frequencies due to negative feedback given through a C-R circuit.

And so, the gain of the amplifier is reduced to protect the motor coil from excessive current when the motor coil is locked.

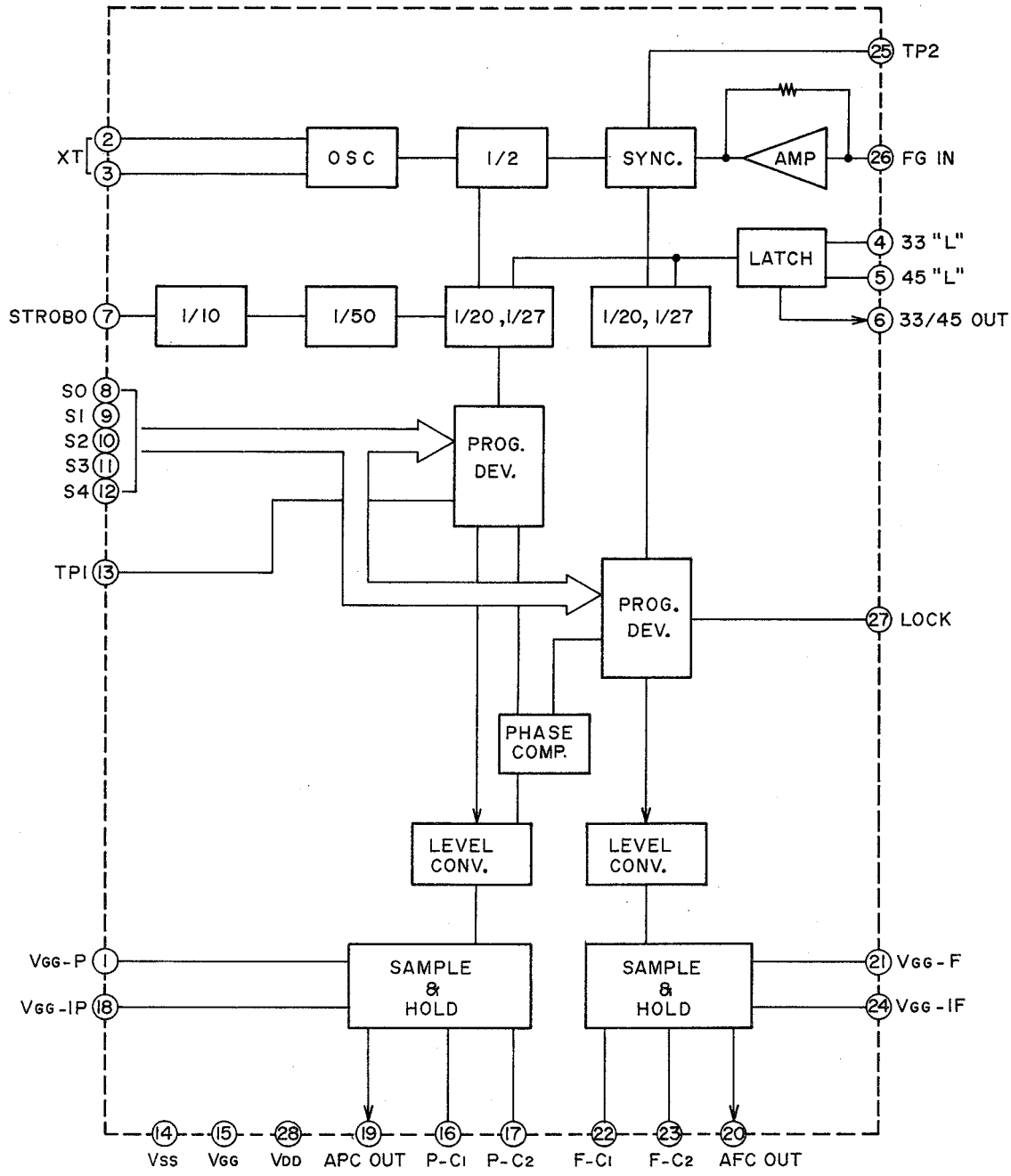


Fig. 27 Pin Connection

IX. EXPLANATION OF HOW THE DC BRUSHLESS DD MOTOR (DDM-73C) WORKS

In the DD motor of AP-Q70/C, a Hall switching element is used to generate a smooth sine wave-like rotating magnetic field and to eliminate noise which conventional brushes might generate. In addition, use of 2-phase coils reduces variation of the driving torque which would otherwise vary with the rotor position, thus ensuring smooth rotation. Operation of the DDM-73C is briefly described below.

Fig. 28 shows the structure of the DDM-73C which is composed of 2-phase, star-shaped coils, eight magnetized rotor poles in NS alteration and the Hall devices at angles of 112.5°.

The Hall devices detect the sinus wave-like variation of the magnetic field occurring when the rotor rotates, and supply the coils with amplified drive currents.

Let us see how one of the coils works. Force F which the coil receives when current i flows (the magnetic pull becomes the actual driving torque) is as follows.

$$F = Bil$$

Where B is the flux density, and 1 the length of the coils which move across the magnetic flux.

The force (vector), which varies with the relative position of the coils and magnets, reaches a maximum in the case shown in Fig. 29-A and is cancelled in the case shown in Fig. 29-B.

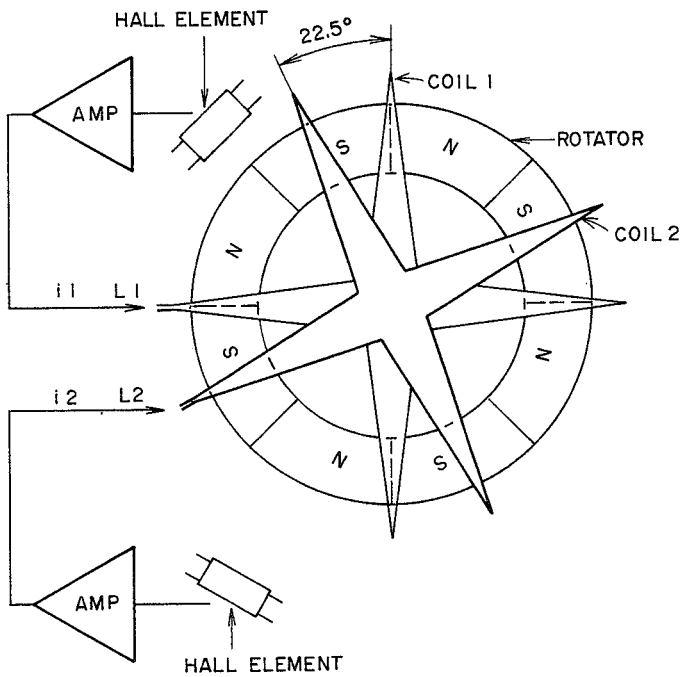


Fig. 28

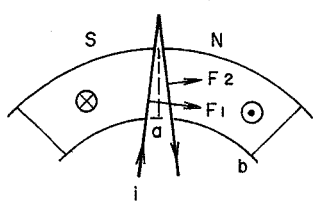


Fig. 29-A

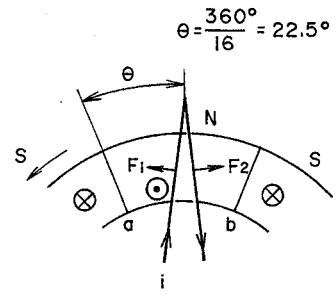


Fig. 29-B

The star shape of the coils causes the force to vary smoothly from maximum (case A) to minimum (case B) in the form of a sine wave. The variation of the force has a cycle which is equal to a quarter rotation, so the driving torque T1 with K as a constant is expressed as follows.

$$T1 = K \cdot il \sin 4\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad ①$$

On the other hand, current i counteracts variation of the magnetic field thus the following relation with I as a constant holds.

$$I = \sin 4\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad ②$$

Thus, equations ① and ② give rise to

$$T1 = K \cdot I \sin^2 4\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad ③$$

Fig. 30 shows this situation.

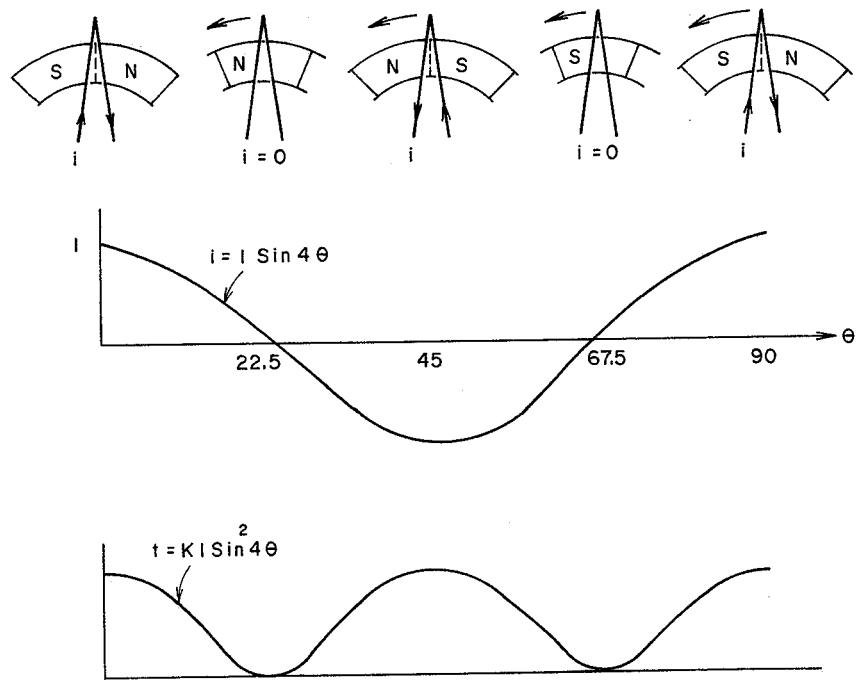


Fig. 30

The other coil is installed with a phase difference of $\pi/2$ (actually at an angle of 22.5°) to the first, and the positions of the associated Hall elements are shifted accordingly. So, current i2 which flows through the second coil is:

$$i2 = I \cos 4\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad ④$$

Driving torque T2 is:

$$T_2 = K \cdot i2 \cos 4\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad ⑤$$

Hence, from equations ④ and ⑤, we have:

$$T_2 = K \cdot I \cos 4\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad ⑥$$

Total driving torque, which is the sum of T1 and T2, is expressed as follows.

$$T_0 = T_1 + T_2 = K \cdot I (\sin^2 4\theta + \cos^2 4\theta) = K \cdot I$$

Thus the composite torque remains constant independently of the angle of rotation as shown in Fig. 31.

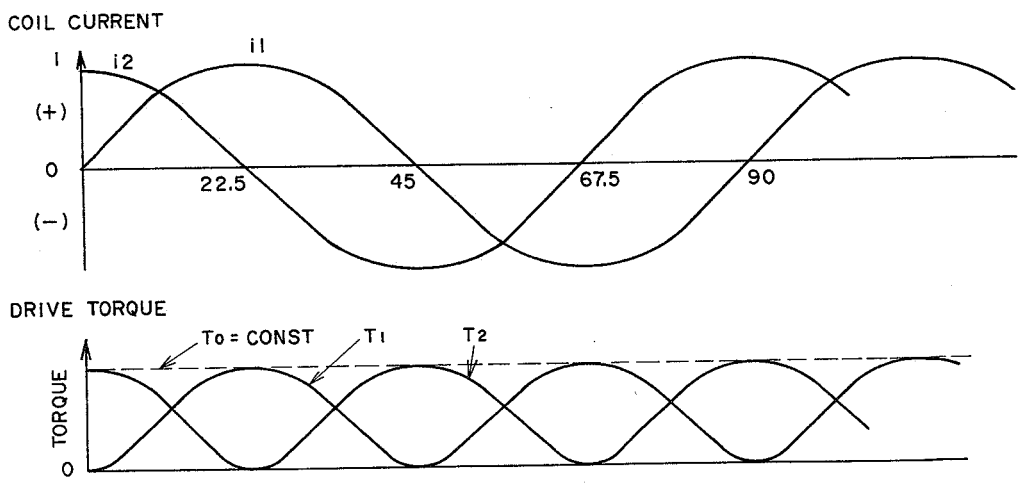


Fig. 31

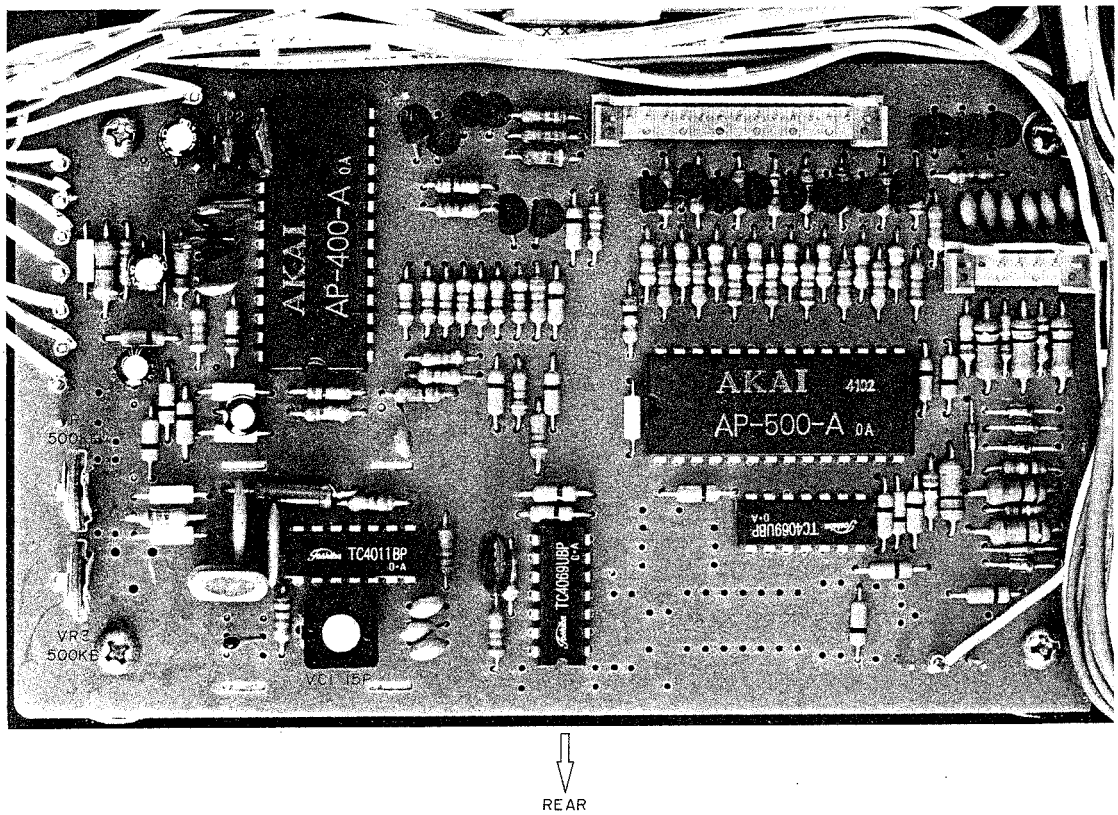


Fig. 32 Synthesizer P.C Board

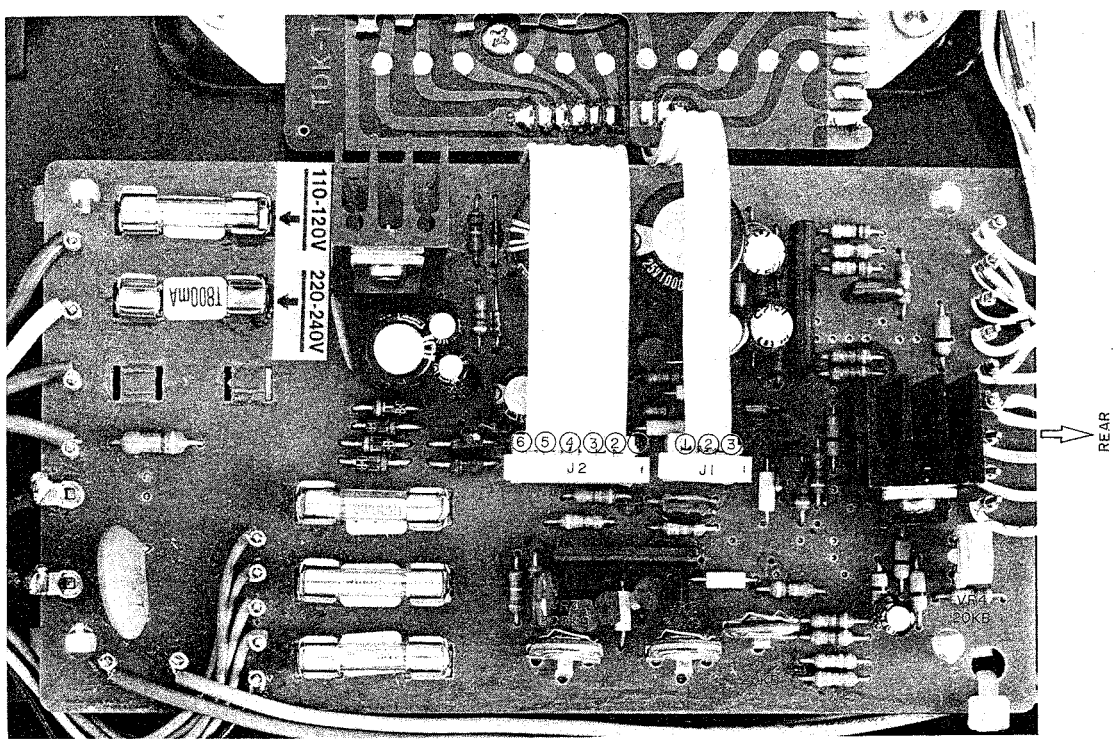


Fig. 33 Motor Driver P.C Board

1. X'tal Oscillation Frequency Adjustment

(Refer to Fig. 32)

1) Connect a frequency counter to IC2 (AP-400-A)'s pin ② terminal.
2) Turn the power switch ON.
3) Adjust VC1 (15P) until the frequency counter reads 2.7 MHz ± 10 Hz.

2. Quartz Lock Adjustment (Refer to Figs 32, 34)

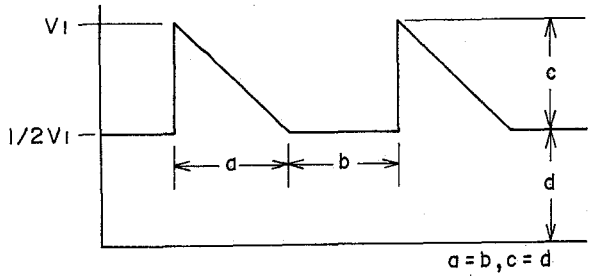


Fig. 34

1) Set the speed selector to 45 rpm and turn the power switch ON.
2) Move the tone arm to rotate the platter.
3) Connect an oscilloscope to test point TP3.
4) Adjust VR1 (500 kB) and VR3 (500 kB) to give the waveform shown in Fig. 6. Please move and adjust both volume controls as there is a tendancy for VR1 to change voltage and VR3 to change tilt.

3. Off-set Voltage Adjustment and Torque Difference Adjustment (Refer to Fig. 33)

1) Remove the platter.
2) Disconnect the motor connection wires to J1 and J2.
3) Short J1 pins ① , ④ and ⑥ .
4) Connect an oscilloscope to J1 pin ① and adjust VR1 (20 kB) to give DC-110mV.
5) Short J2 pins ③ , ④ and ⑤ .
6) Set VR3 (300 kB) to the centre.
7) Connect an oscilloscope to J1 pin ③ and adjust VR2 (20 kB) to give DC-110mV.
8) Re-connect the motor connection wires to J1 and J2. Connect a 2ch AC voltmeter to J1 pins ①, ② (GND) and ③ .
9) Replace the platter, move the tone arm away from the tone arm rest slightly, depress the start key and revolve the platter. (45 rpm)
10) Adjust VR3 (300 kB) until the deflection of the AC voltmeter is the same.

NOTE: 1. The power switch should be off while shorting the terminals or disconnecting connection wires.
2. After adjustment, playback the 3,000 Hz test record and confirm that the Wow and Flutter is less than 0.025% (JIS).
If out, re-adjust VR1 to 3.

4. Phase Angle Adjustment (Refer to Figs. 32, 33 and 35)

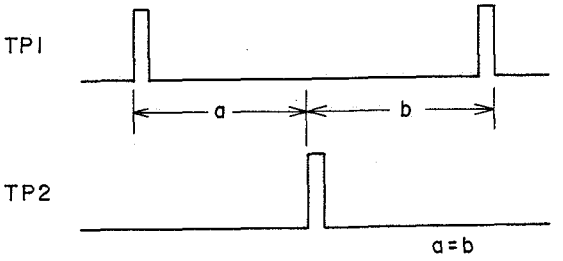


Fig. 35

1) Turn the power switch ON.
2) Move the tone arm away from the tone arm rest slightly, depress the start key and revolve the platter. (45 rpm)
3) Connect the oscilloscope CH1 to TP1 and CH2 to TP2.
4) Adjust VR4 (20 kB) until waveform TP2 comes to the centre of waveform TP2.

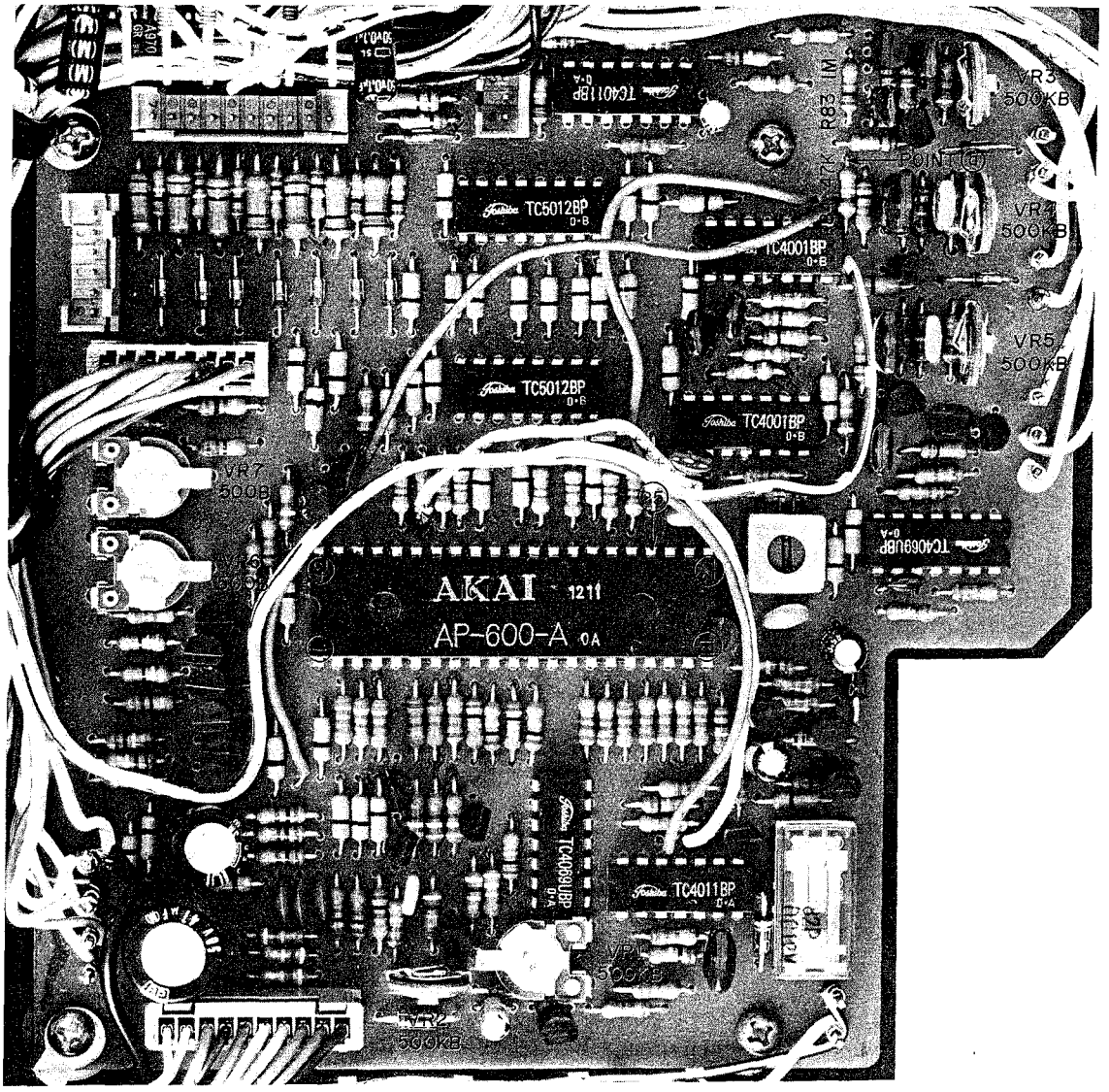


Fig. 36 Arm Control P.C Board

1. Basic Clock Oscillation Frequency Adjustment (Refer to Fig. 36)

1) Connect a frequency counter to terminal 25 of IC1 (AP-600-A).
2) Turn T1 and adjust until the frequency counter reads 490 kHz ± 1 kHz.

2. Arm Sensor Sensitivity Adjustment (Refer to Figs. 36 to 38)

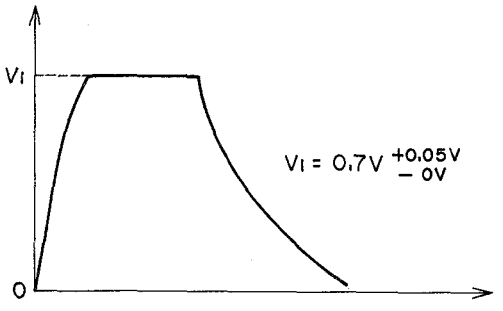


Fig. 37

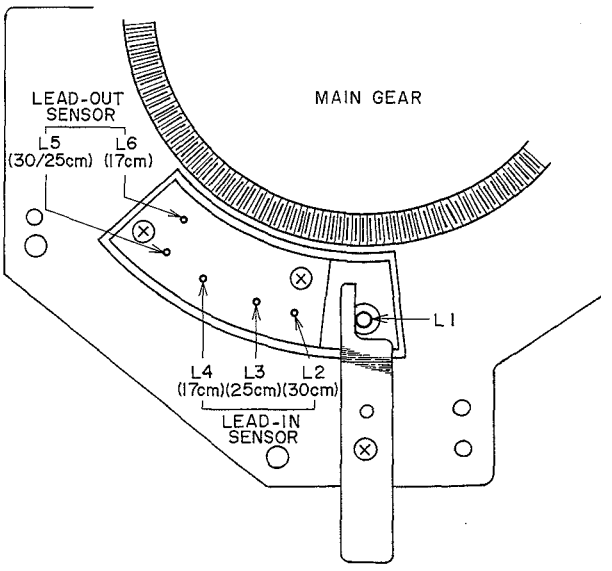


Fig. 38

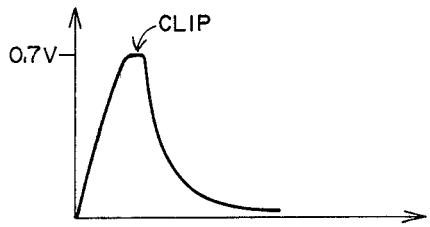


Fig. 39

1) Remove the platter.
2) Connect an oscilloscope probe to VR2's center.
3) Bring the tone arm manually over to the 25 cm record lead-in position and input L3's light. VR2 should be turned counter-clockwise.
4) Look at the oscilloscope and turn VR2, adjusting until Fig. 9's V1 is within $0.7V^{+0.05V}_{-0V}$.
5) When the adjustment is complete, move the tone arm a fraction manually and confirm the adjustment point is at maximum.

3. Adjusting to the Amount of Light in the Arm Sensor LED. (Refer to Figs. 36 to 38)

1) Connect an oscilloscope probe to VR2's center.
   Bring the tone arm over to the 30 cm record lead-in position, search for the place where L2 light is input and still moving the arm slightly fix where the voltage is maximum.
2) Adjust VR6 in the same way as VR2.
3) Bring the tone arm over to the 17 cm record lead-in position, search for the place where L4 light is input and still moving the arm slightly fix where the voltage is maximum.
4) Adjust VR7 in the same way as VR2.

NOTE: Please carry out the following checks after items 2) and 3).
1. Move the tone arm away from the tone arm rest and depress the start key.
2. Check that the tone arm is down, then bring to the lead-in position on 25/30 cm records and confirm the waveform is the one shown in Fig. 11.
3. You may clip if the waveform exceeds 0.7 V.
4. Carry out the same checks at the lead-out position on 17 cm records.
5. If a 0.7 V waveform is not obtained during these checks, re-adjust V1 by VR2 adjustment and check.

4. Record Size Sensor Sensitivity Adjustment

4-1. 17 cm Record Position (Refer to Figs. 36, 40)

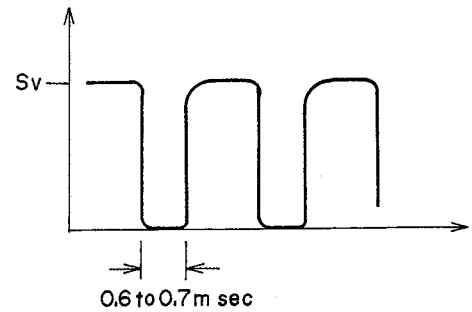


Fig. 40

1) Connect a probe to point ⓐ of R84.
2) Replace the rubber mat on the platter, place a 17 cm record and move with a finger until the hole in the platter comes to the size sensor.
3) Adjust VR3 until the oscilloscope waveform in Fig. 40 is obtained.
4) Revolve the platter once and check that the pulse wave only enters the places where there are holes. Next check that the waveform in Fig. 40 appears at each hole.
   If the pulse wave is entering places other than the holes, re-adjustment values is less sensitive than the allowance, stop reflection.

4-2. 30 cm Record Position (Refer to Figs. 36, 41)

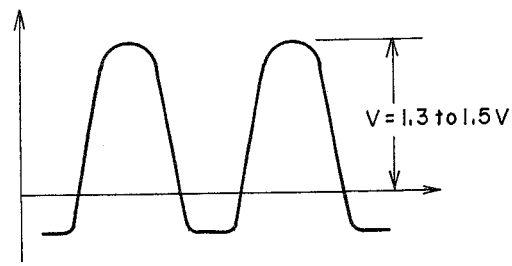


Fig. 41

1) Connect a probe to VR4's center.
2) Place a 30 cm record on the platter and match the size sensor with the hole in the platter.
3) Adjust VR4 until the oscilloscope waveform reassembles that in Fig. 41.
4) Check that the waveforms at other holes are also the same as Fig. 41.

4-3 25 cm Record Position (Refer to Figs 36, 41)

1) Connect a probe to VR5's center.
2) Place a 25 cm record on the platter and adjust VR5 as in item 4-2.

5. Electro-Magnetic Clutch Constant Adjustment (Refer to Figs. 37, 43)

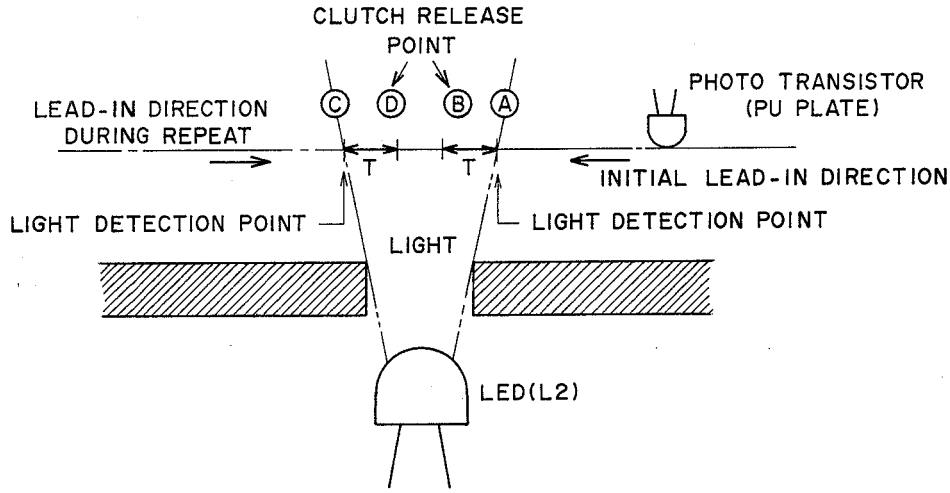


Fig. 42

With repeat play, when lead-in occurs for the first time, the PU plate with photo transistor attached moves to the left and L2 light is input at point A. Then the time (T) only determined by VR1 is delayed, the clutch released at point B and the needle descends.
Next when it leads in for repeat playback, it moves to the right, L2 light is input at point C, T alone is delayed, the clutch released at point D and the needle descends. Adjust VR1 to change T and match points B and D.

1) Place a 30 cm record on the platter and set for lead-in at 30 cms.
2) Depress the repeat key for repeat playback.
3) Depress the start key for auto lead-in and check the position where the needle descends.
4) Take the tone arm to the lead-out position to repeat lead-in.
   Check the position where the needle descends.
5) Adjust VR1, adjusting while repeating items 3) and 4) until the first lead-in position and the repeat lead-in position are the same.

6. Angle Installation Position Adjustment (Refer to Figs. 43, 44)

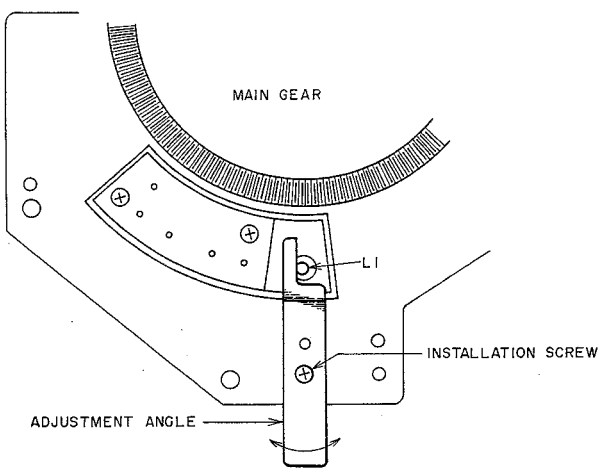


Fig. 43

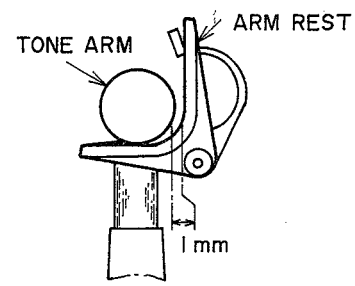


Fig. 44

1) L1 detects whether or not the tone arm has returned to rest, release the electro-magnetic clutch and stops the tone arm.
   The adjustment angle decides the position where the PU plate photo transistor detects L1's light by interupting L1's light.
2) Carry out auto return and when the tone arm has returned to rest, loosen the adjustment angle screw and adjust until the gap between the tone arm and the tone arm rest is about 1mm.

XII. MECHANICAL ADJUSTMENT

1. Motor Gear Installation Position Adjustment

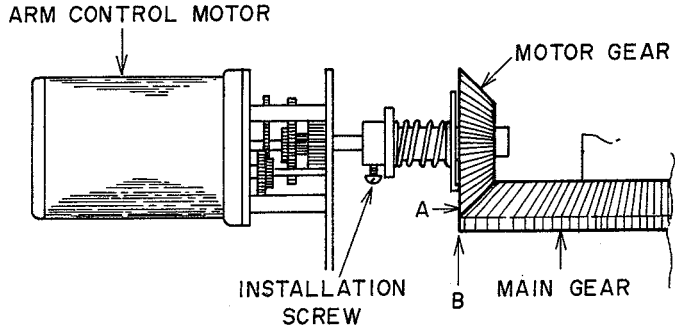


Fig. 45

Loosen the fixed screw and adjust until section A of the motor gear and section B of the main gear are aligned as in Fig. 45.

2. Stylus Pressure Adjustment

Fig. 46

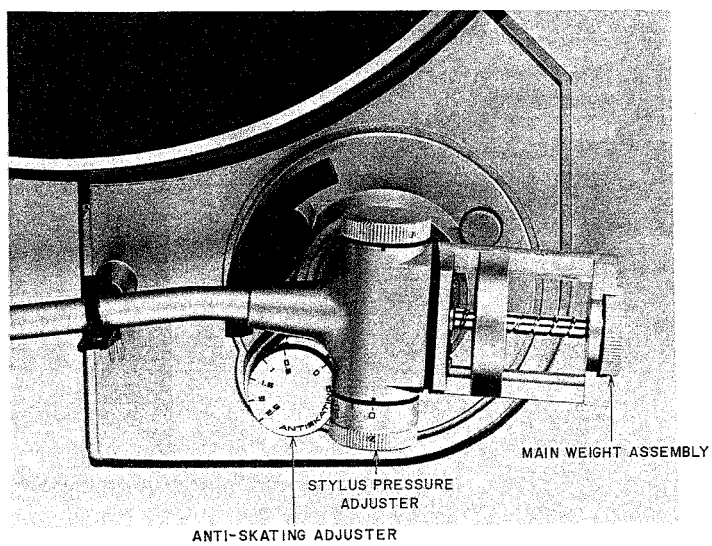
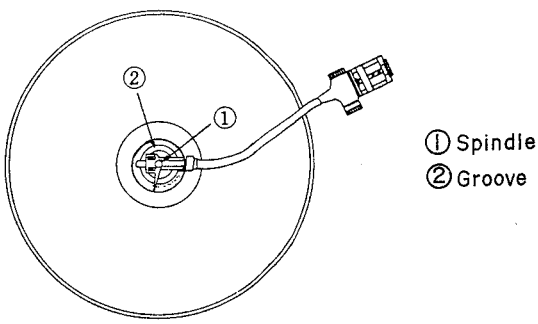


Fig. 47

1) Power switch ON.
2) Turn the Anti-Skating Adjuster and Stylus Pressure Adjuster to 0.
3) Unlock the Tone Arm and move towards the turntable.
   Remove the Stylus Cover and be careful not to damage the stulus.
4) Press ARM key to lower Arm Lifter.
5) Keep the Tone Arm stationary half way between the Tone Arm Rest and the Turntable platter and adjust the ballast until perfect holizontal balance is obtained. To increase ballast weight, turn clockwise and to decrease, counterclockwise.
6) Press the CUT Key to return the Tone Arm precisely onto the Tone Arm Rest.
7) Lock the Tone Arm and set the stylus pressure weight recommended for your cartridge with the Stylus Pressure Adjuster only.
   The adjustment range is from 0 to 2.5 grams.
   * For AP-Q80C only: The stylus pressure for the supplied Ortofon LMB-12 stylus is 1.5 grams.
8) Set the Anti-Skating Adjuster to corresponding stylus pressure weight.

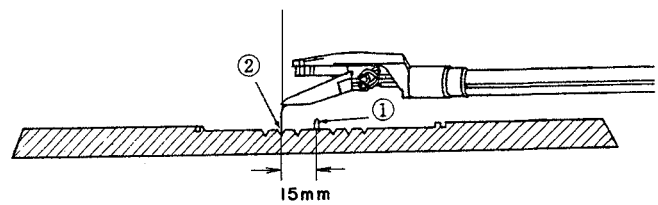
NOTE: When the Tone Arm is not fully on the Tone Arm Rest, Auto-Play will not be activated and only manual playback opration will be passible.

3. Overhang Adjustment



(a)

Fig. 48-A



(b)

Fig. 48-B

1) Move the Tone Arm to the center of turntable.
2) Adjust the cartridge position so that the stylus is in line with the Middle Groove Ring.
   * The cartridge position can be adjusted by re-setting the Cartridge Re-setting Screws.

4. Tone Arm Height Adjustment

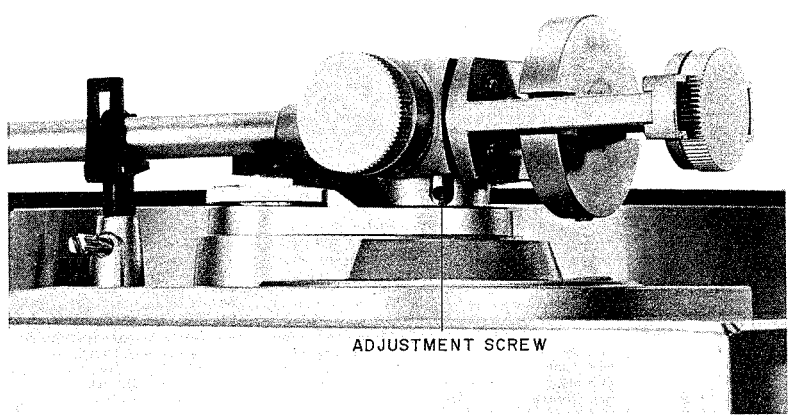


Fig. 49

The Tone Arm should be parallel with the record surface.
To adjust the arm height, insert the hexagon wrench into the adjustment hole (see Fig. 49) and turn. Adjustment of up to 5 mm is possible.

5. Tone Arm Lifter Adjustment

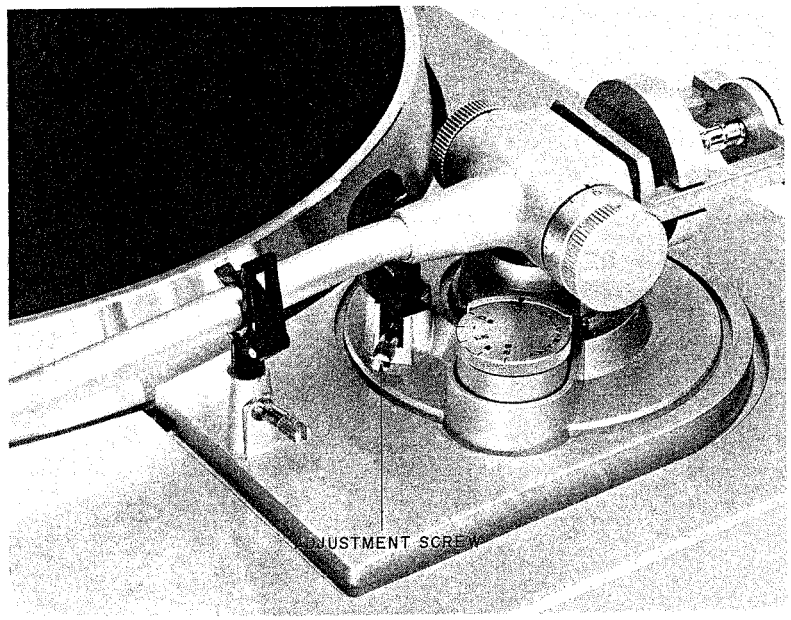


Fig. 50

With the Tone Arm Lifter in upper position, the stylus should rise to 8 mm above the record surface.
If it does not rise to the required height, increase elevation by adjusting the Tone Arm Lifter Elevation Adjustment Screw (see Fig. 50).

6. Tone Arm Rest Adjustment

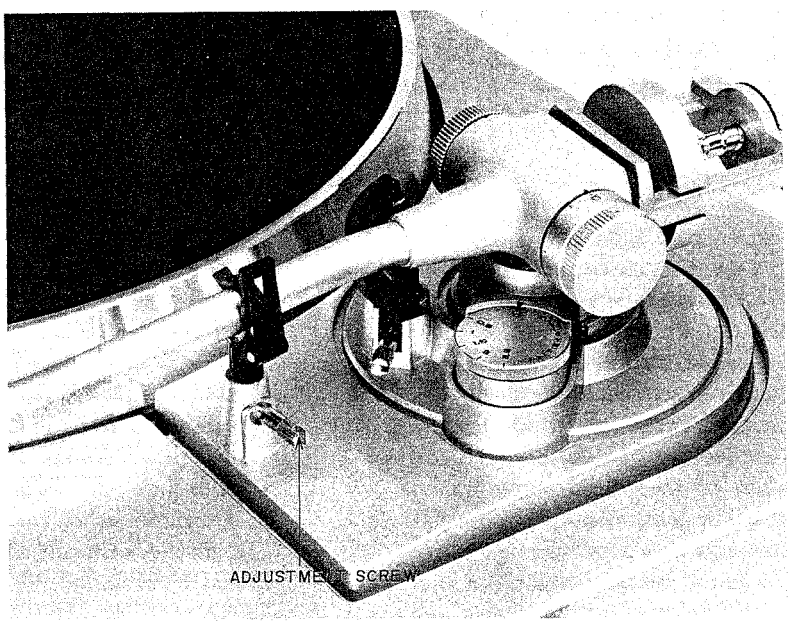


Fig. 51

With the Tone Arm Lifter in upper position, use the Tone Arm Rest Height Adjustment Screw to adjust the Tone Arm Rest to the same height as the Tone Arm Lifter (see Fig. 51)

7. Lead-in Position Adjustment

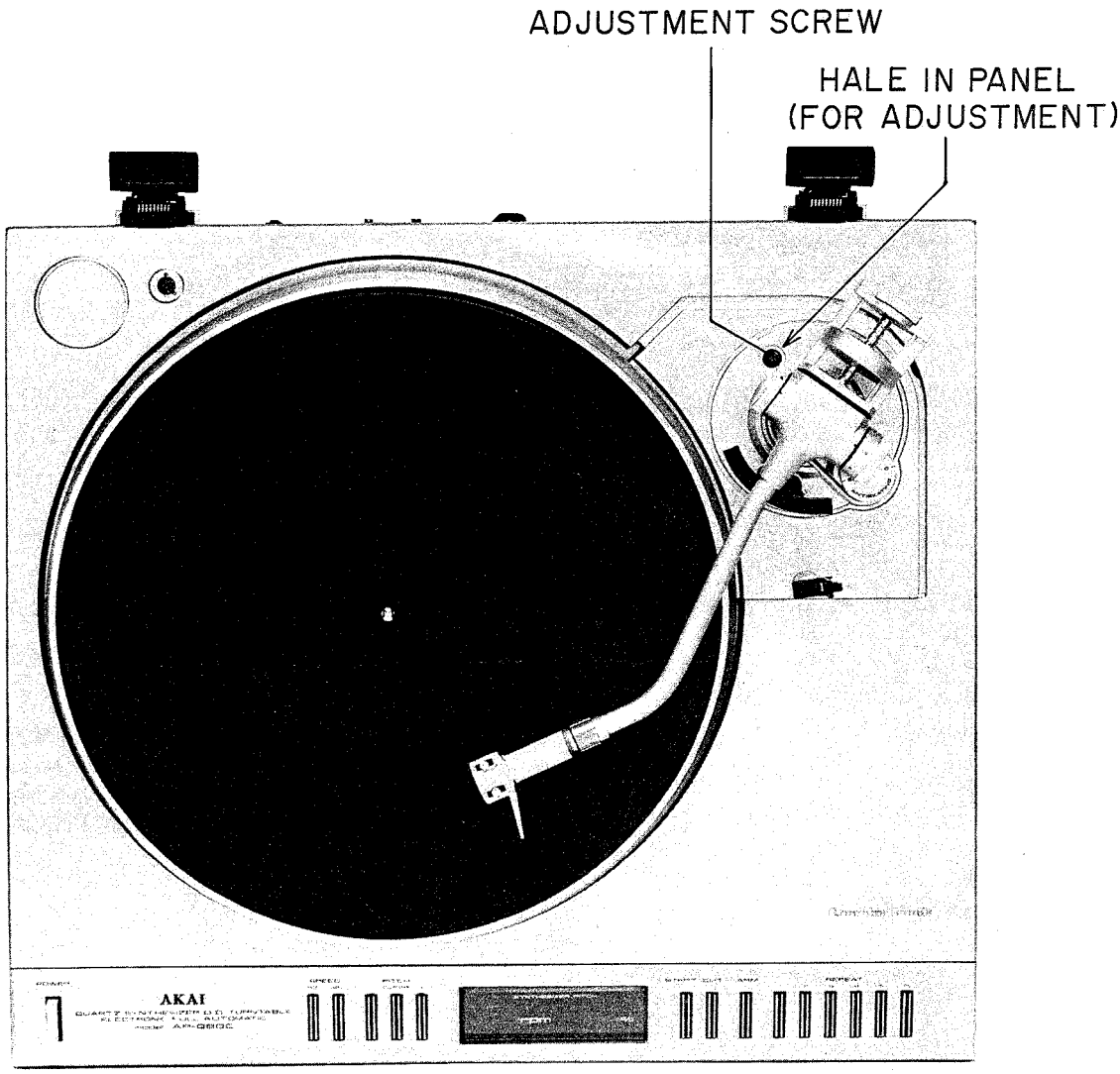


Fig. 52

Remove the rubber cap from the tone arm stand. As illustrated in Fig. 24, when the tone arm is shifted from the tone arm rest nearly to the position where the lead-out motion starts, the adjustment screw appears in the hole from which the rubber cap has been removed. Turning the adjustment screw clockwise and counterclockwise permits the lead-in position to move towards the center of the disc record and towards the outer rim of the record respectively. Therefore, lead-in position adjustment is performed by turning the adjustment screw as follows:

Clockwise — To move the lead-in position towards the center of the record.

Counterclockwise — To move the lead-in position towards the outer rim of the record.

NOTE: 1) The unit is factory adjusted so that, when using the ortofon Model LMB-12 cartridge, and 30-cm/25-cm/17-cm JIS records, the stylus descends to the record surface within the range of 293 ~ 298 ϕ, 242 ~ 247 ϕ or 168 ~ 173 ϕ (with the turntable spindle as the diameter center point). Sonosheets or records not in accordance with JIS dimension standards have entirely different lead-in positions. Therefore, when using such records, play them by manually instead of adjusting the lead-in position with the adjustment screw.

2) Be sure to replace the rubber cap after adjustment.

XIII. CLASSIFICATION OF VARIOUS P.C BOARD

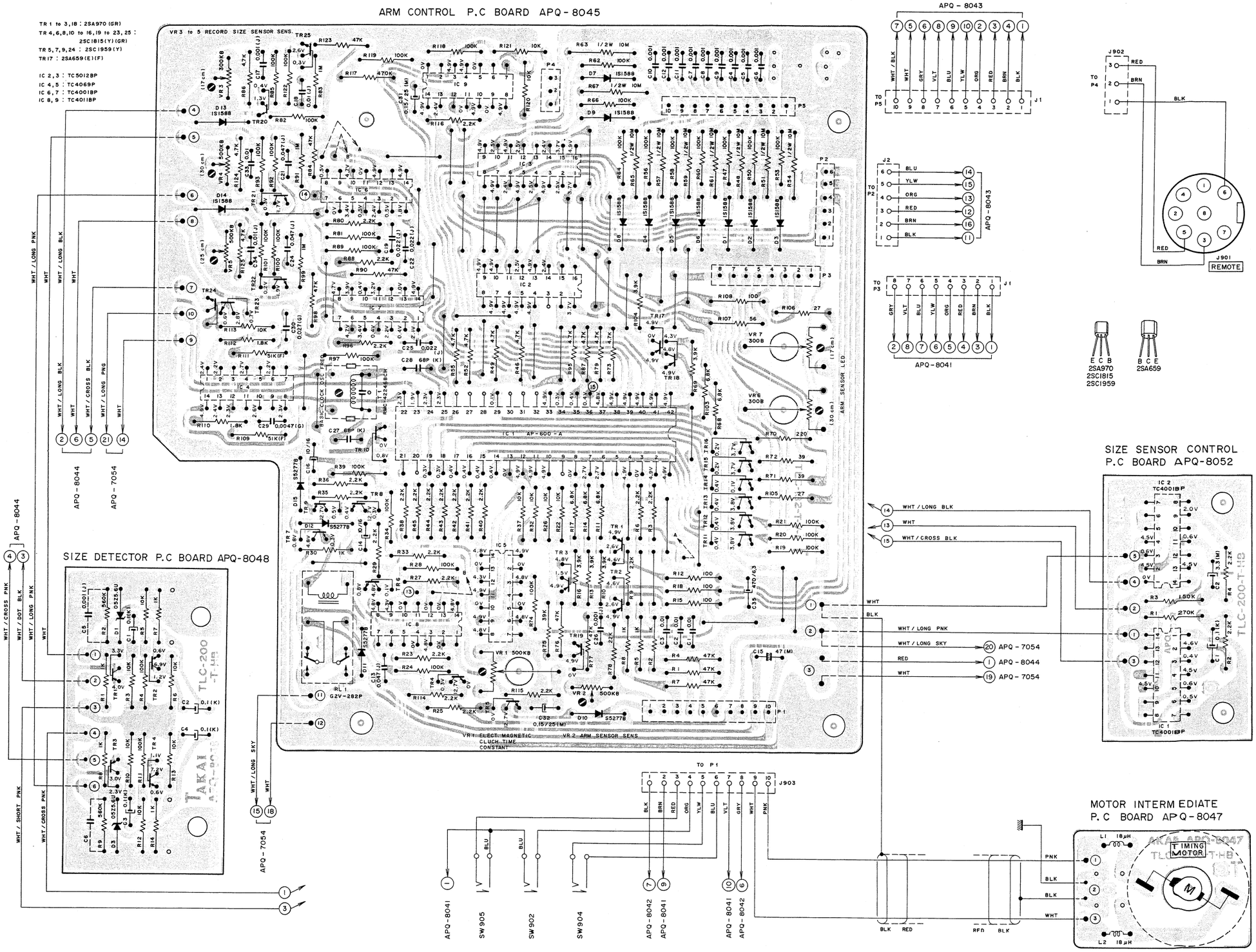
1. P.C Board Titles and Identification Numbers

P.C Board Title	P.C Board Number
FG Sensor P.C Board	APQ-5012
Synthesizer P.C Board	APQ-7049
Touch Switch P.C Board (A)	APQ-7050
LED P.C Board	APQ-7052
Motor Drive P.C Board	APQ-7054
Photo Transistor P.C Board	APQ-8040
LED P.C Board (B)	APQ-8041
Intermediate P.C Board	APQ-8042
Touch Switch P.C Board (C)	APQ-8043
Size Sensor P.C Board	APQ-8044
Arm Control P.C Board	APQ-8045
Motor Intermediate P.C Board	APQ-8047
Size Detector P.C Board	APQ-8048
Size Sensor Control P.C Board	APQ-8052

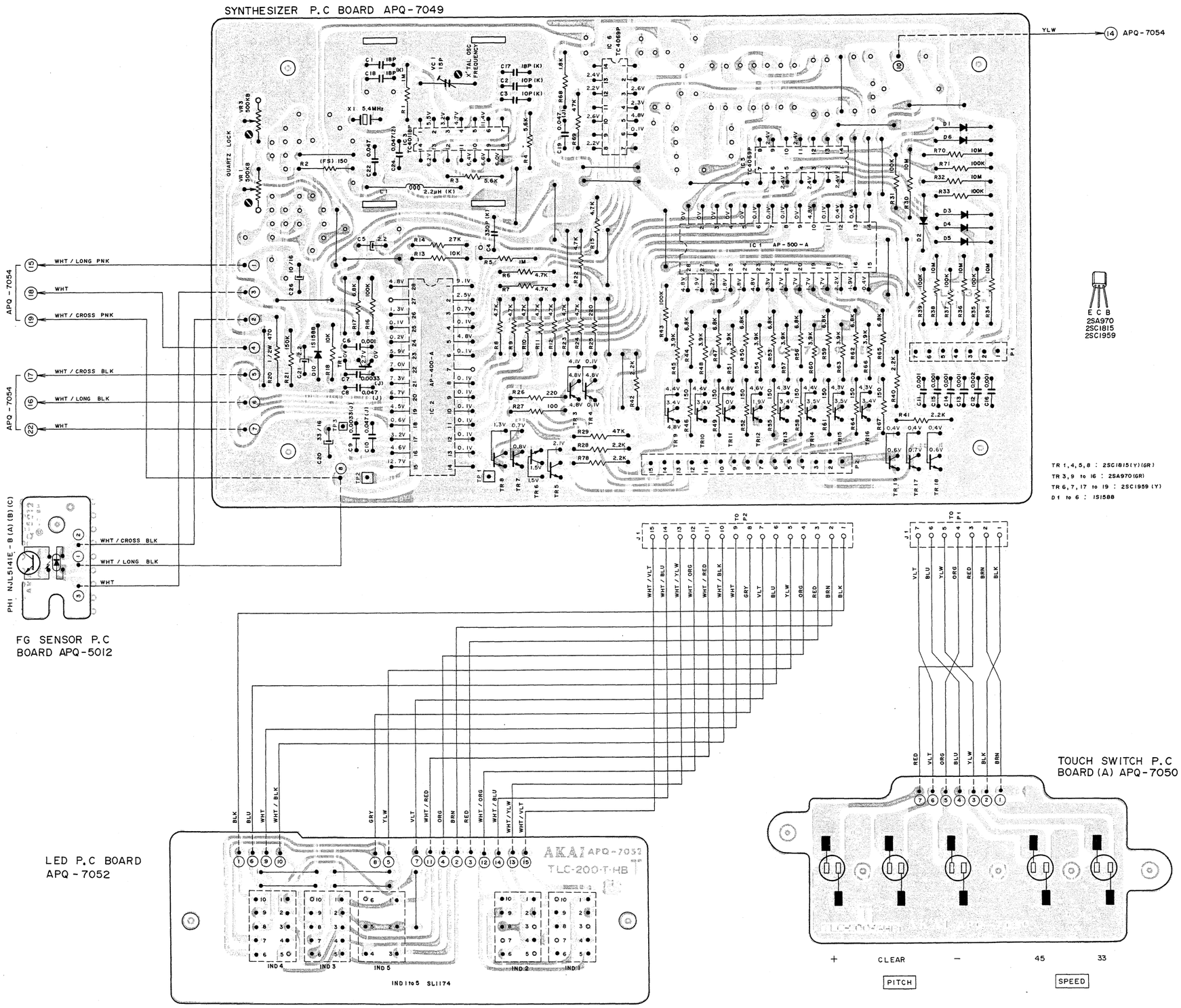
Chart 4

2. COMPOSITION OF VARIOUS P.C BOARDS

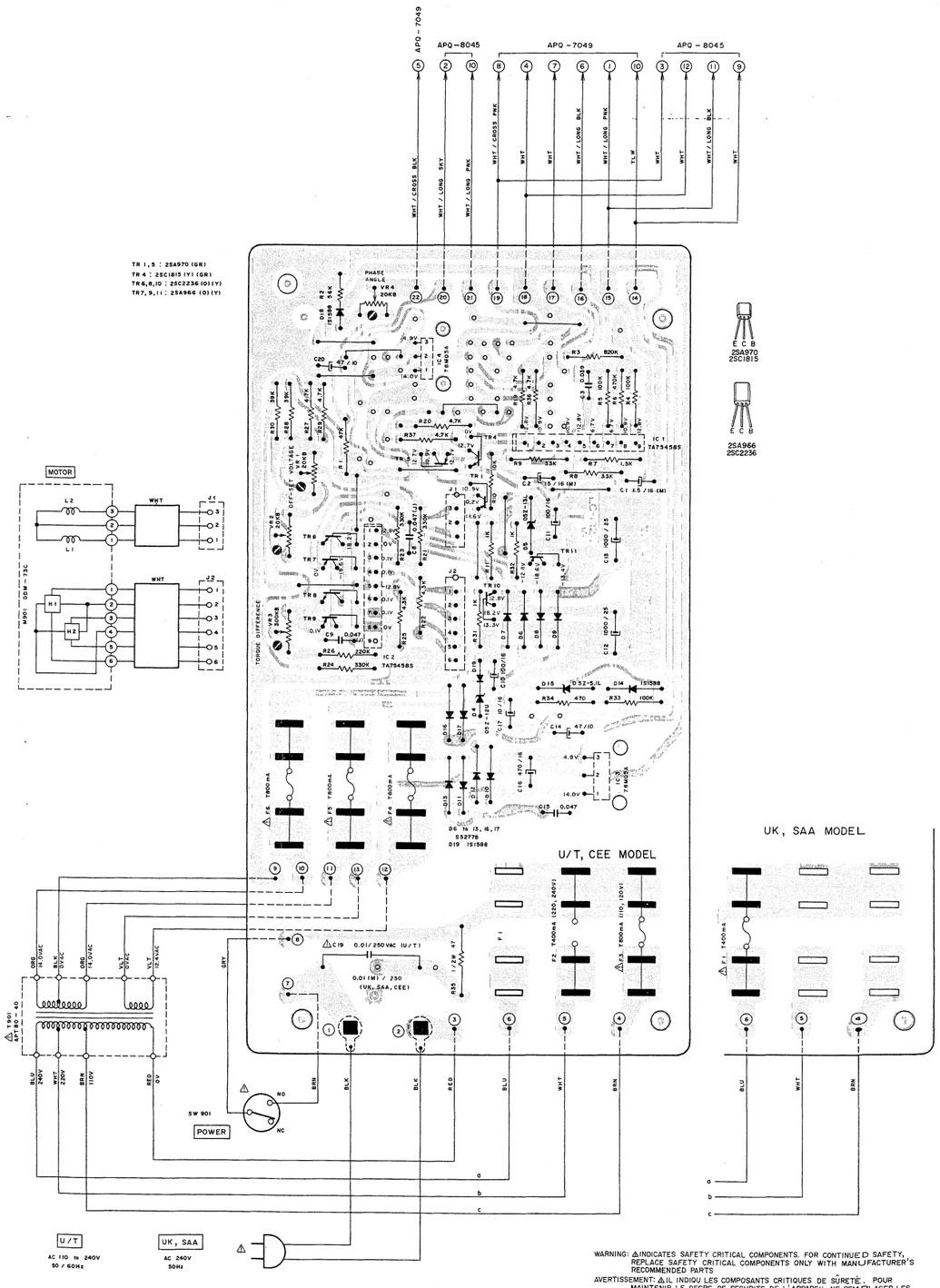
1) Arm Control P.C Board APQ-8045 (2ED), Size Detector P.C Board APQ-8048, Size Sensor Control P.C Board APQ-8052 and Motor Intermediate P.C Board APQ-8047



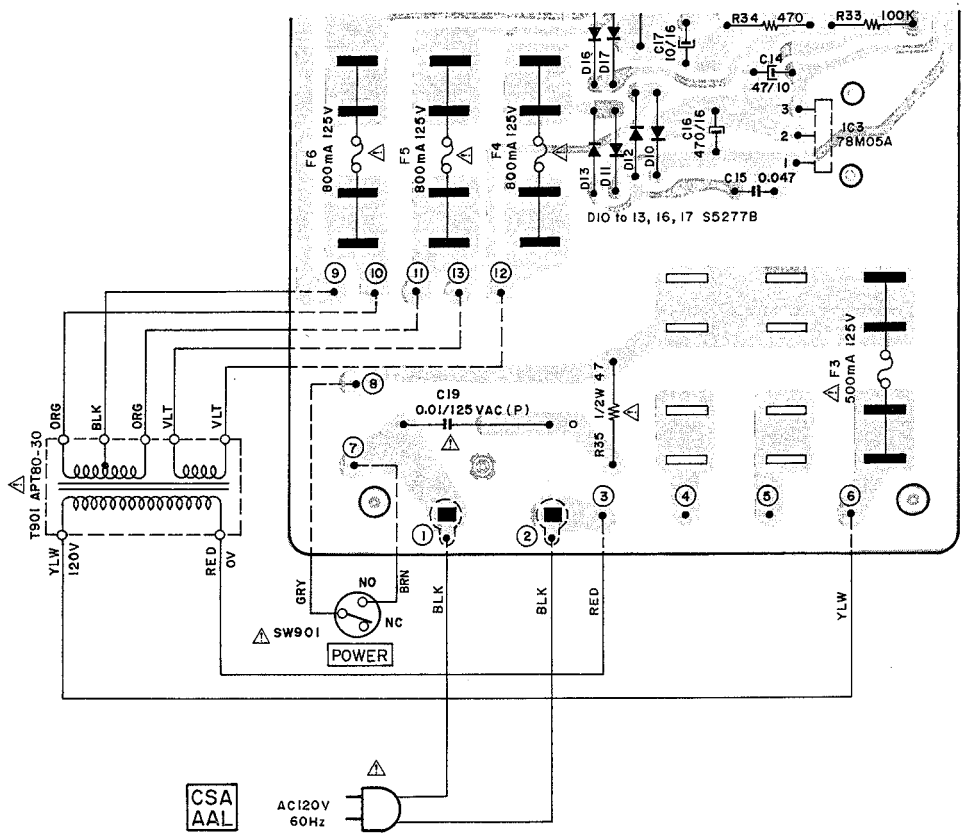
2) Synthesizer P.C Board APQ-7049 (2ED), LED P.C Board APQ-7052, Touch Switch P.C Board (A) APQ-7050 and FG Sensor P.C Board APQ-5012



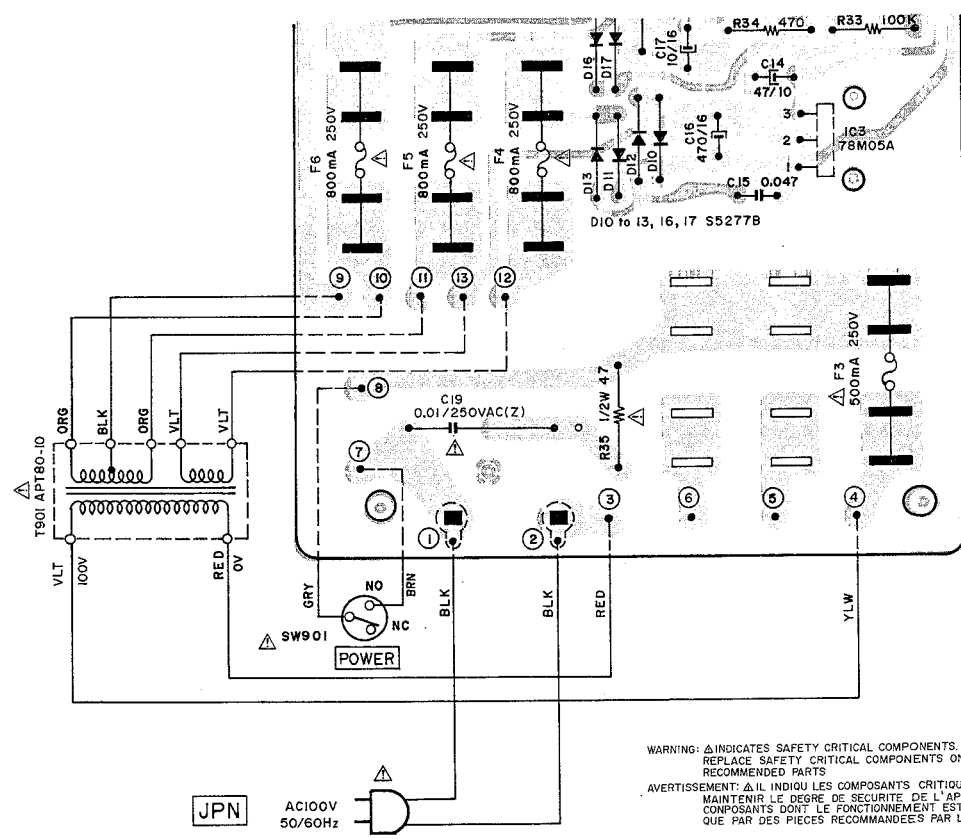
3) Motor Drive P.C Board APQ-7054 (2ED) (U/T, UK, SAA)



4) Motor Drive P.C Board (2ED) (CSA, AAL)



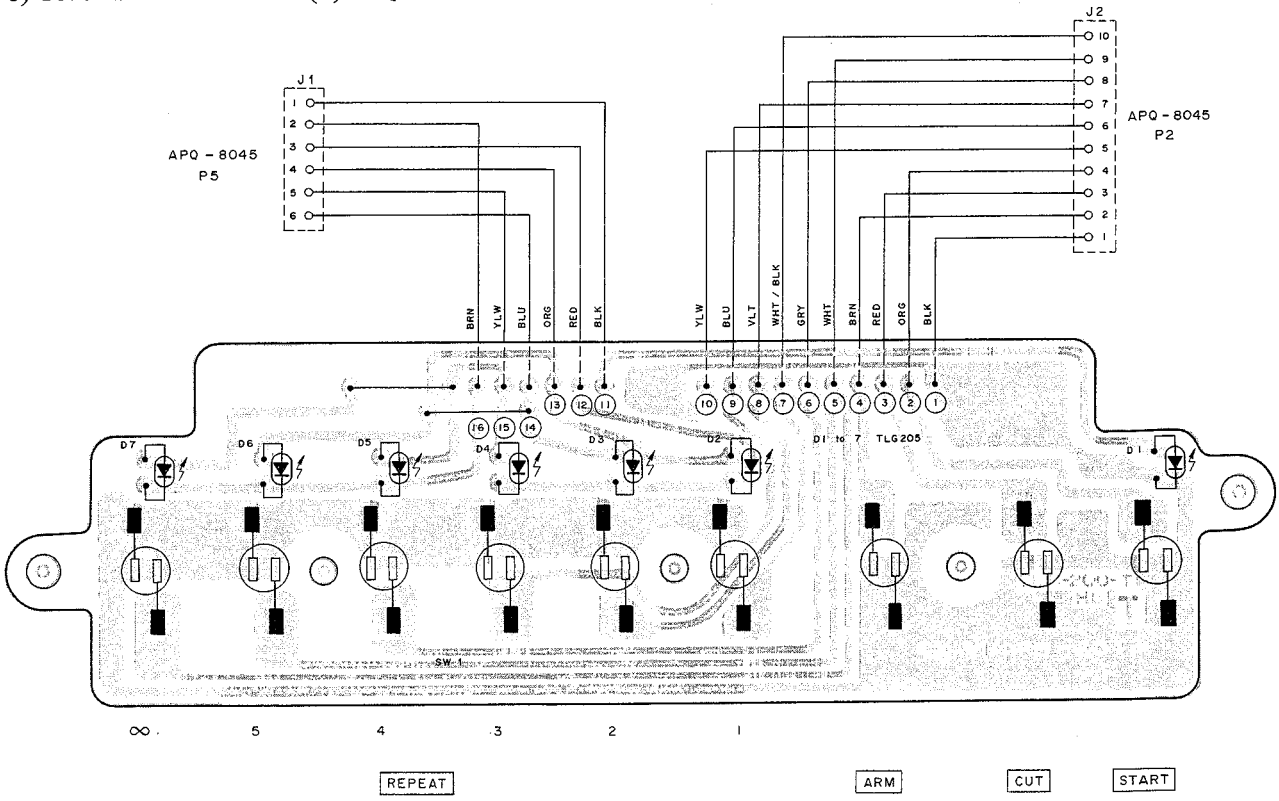
5) Motor Drive P.C Board (C) (2ED) (JPN)



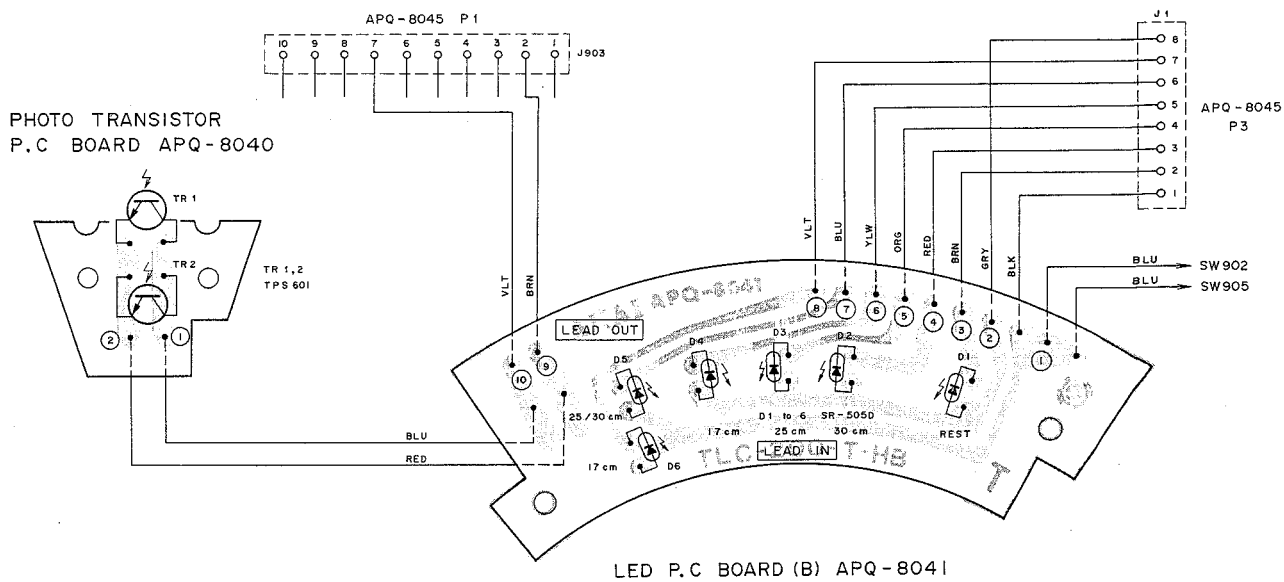
WARNING: ⚠INDICATES SAFETY CRITICAL COMPONENTS. FOR CONTINUED SAFETY, REPLACE SAFETY CRITICAL COMPONENTS ONLY WITH MANUFACTURER'S RECOMMENDED PARTS

AVERTISSEMENT: ⚠IL INDIQU LES COMPOSANTS CRITIQUES DE SÛRETÉ. POUR MAINTENIR LE DEGRE DE SECURITE DE L'APPAREIL NE REMPLACER LES CONPOSANTS DONT LE FONCTIONNEMENT EST CRITIQUE POUR LA SECURITE QUE PAR DES PIECES RECOMMANDEES PAR LE FABRICANT

6) Touch Switch P.C Board (C) APQ-8043

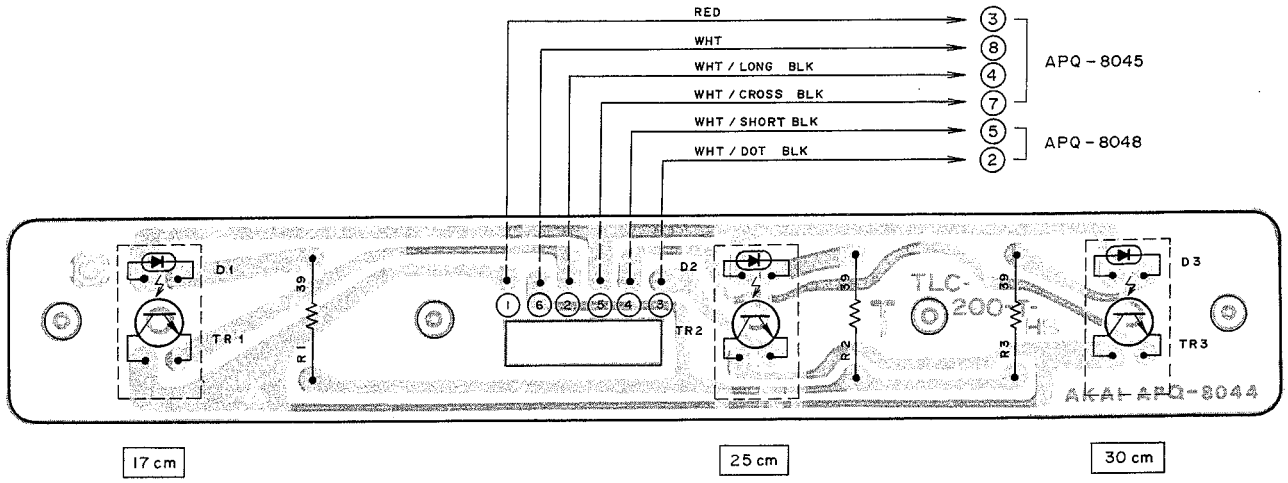


7) LED P.C Board (B) APQ-8041 and Photo Transistor P.C Board APQ-8040

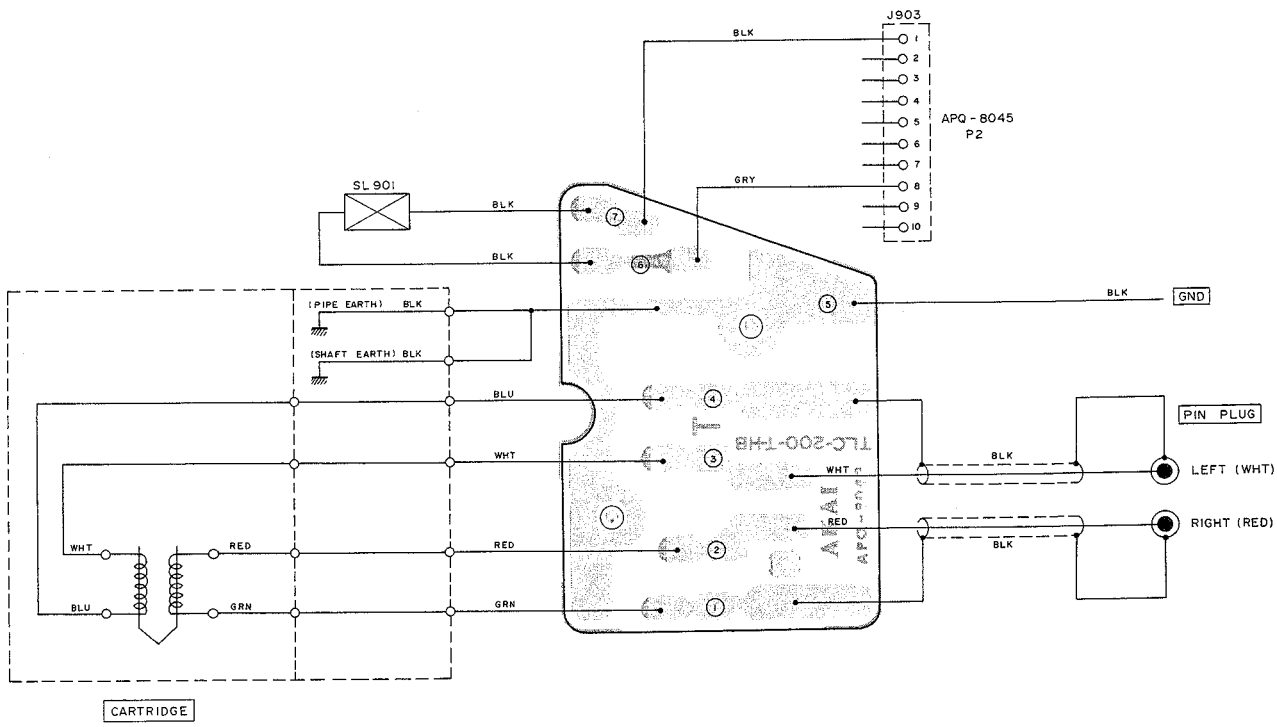


LED P.C BOARD (B) APQ-8041

8) Size Sensor P.C Board APQ-8044



9) Intermediate P.C Board APQ-8042



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SECTION 2

PARTS LIST

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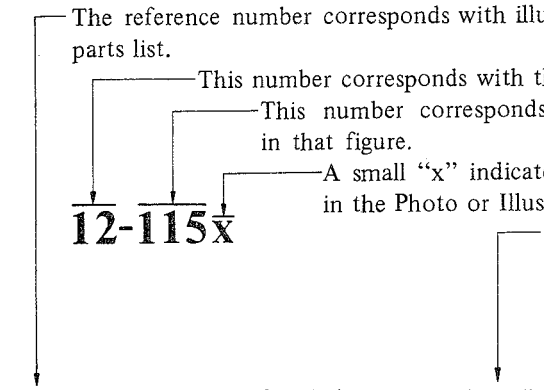
1. RECOMMENDED SPARE PARTS LIST 52
2. SYNTHESIZER P.C BOARD (APQ-7049) BLOCK 54
3. MOTOR DRIVE P.C BOARD (APQ-7054) BLOCK 54
4. ARM CONTROL P.C BOARD (APQ-8045) BLOCK 55
5. SIZE SENSOR P.C BOARD (APQ-8044) BLOCK 55
6. SIZE DETECTION P.C BOARD (APQ-8048) BLOCK 55
7. SIZE SENSOR CONTROL P.C BOARD (APQ-8052) BLOCK 55
8. ASSEMBLY BLOCK (1) 56
9. ASSEMBLY BLOCK (2) 58

INDEX 60

Resistor and Capacitor which is not listed in this parts list, please refer to COMMON LIST FOR SERVICE PARTS.

HOW TO USE THIS PARTS LIST

1. This parts list is compiled by various individual blocks based on assembly process.
2. When ordering parts, please describe parts number, serial number, and model number in detail.
3. How to read list.


The reference number corresponds with illustration or photo number of that particular parts list.
This number corresponds with the Figure Number.
This number corresponds with the individual parts index number in that figure.
A small "x" indicates the inability to show that particular part in the Photo or Illustration.
12-115x
Schematic Diagram Number of individual manufactured part.
(not required for parts order)

Ref. No.	Parts No.	Description	Schematic No.
		FLYWHEEL BLOCK #13	
12-115x	800425	Flywheel Block Assy. Comp.	RDG #13
12-116	244506	Flywheel Only	RD-233
12-117x	244754	Felt, Flywheel	RD-275
12-118	251324	Main Metal Case	RD-236
12-119	253080	Main Metal	RD-237

4. The symbol numbers shown on the P.C. Board list can be matched with the Composite Views of components of the Schematic Diagram or Service Manual.
5. The indications of Resistors and Capacitors in the photos of P.C. Board are being eliminated.
6. The shape of the parts and parts name, etc. can be confirmed by comparing them with the parts shown on the Electrical Parts Table of P.C. Board.
7. Both the kind of part and installation position can be determined by the Parts Number. To determine where a parts number is listed, utilize Parts Index at end of Parts List.
   It is necessary first of all to find the Parts Number. This can be accomplished by using the Reference Number listed at right of parts number in the Parts Index. (meaning of ref. no. outlined in Item 3 above).
8. Utilize separate "Price List for Parts" to determine unit price. The most simple method of finding parts Price is to utilize the reference number.

CAUTION:

1. When placing an order for parts, be sure to list the parts no. model no., and description. There are instances in which if any of this information is omitted, parts cannot be shipped or the wrong parts will be delivered.
2. Please be careful not to make a mistake in the parts no. If the parts no. is in error, a part different from the one ordered may be delivered.
3. Because parts number and parts unit supply in the Preliminary Service Manual (Basic Parts List) may be partially changed, please use this parts list for all future reference.

WARNING: ⚠ INDICATES SAFETY CRITICAL COMPONENTS. FOR CONTINUED SAFETY, REPLACE SAFETY CRITICAL COMPONENTS ONLY WITH MANUFACTURER'S RECOMEMNDED PARTS.

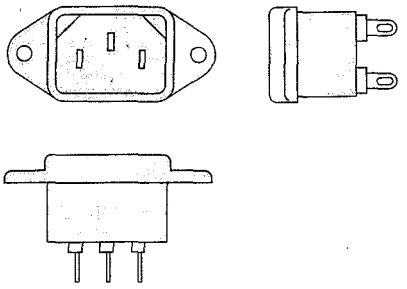
AVERTISSEMENT: ⚠ IL INDIQU LES COMPOSANTS CRITIQUES DE SURETE. POUR MAINTENIR LE DEGRE DE SECURITE DE L'APPAREIL NE REMPLACER LES COMPOSANTS DONT LE FONCTIONNEMENT EST CRITIQUE POUR LA SECURITE QUE PAR DES PIECES RECOMMANDEES PAR LE FABRICANT.

AC INLET SYSTEM

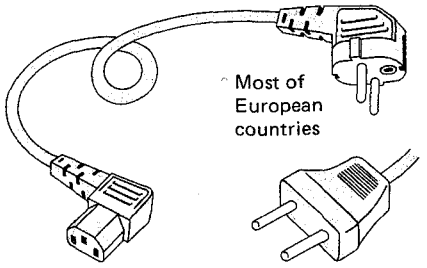
This model is equipped with an AC INLET SYSTEM. Please refer to the AC INLET SYSTEM CHART below for the specific type. By the AC INLET SYSTEM, AC (mains) cord can be connected to and disconnected from the model because the model is provided with socket exclusively for AC (mains) cord on its main body.
Please note, however, that certain models are not equipped with this system and has a built-in AC (mains) cord as before.

AC INLET SYSTEM CHART

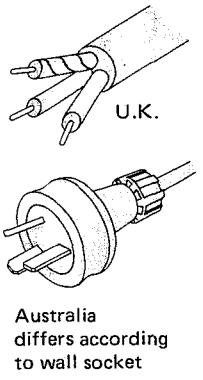
CLASS I



Picture 1
AC INLET to be installed on machines

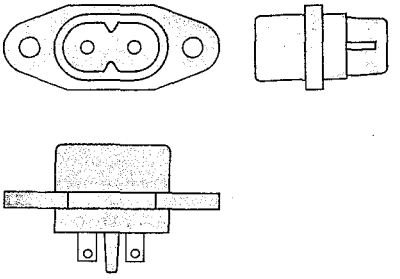


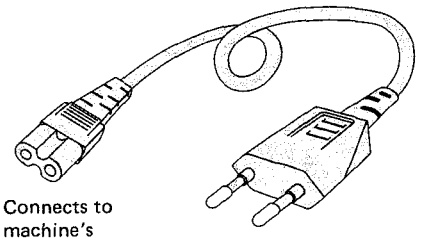
Picture 2
AC (mains) cord

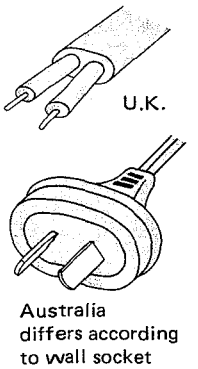


CLASS II

▣ *This mark indicating double insulation* will be attached to machine's rear panel







Parts List for AC (mains) Cord Set

Standard		Description	Type of AC Inlet	Parts No.
Class I	CEE	Cord Set CEE (3 cores)	3P	EW302993
	BEAB	Cord Set BEAB (3 cores)	3P	EW302994
	SAA	Cord Set SAA (3 cores)	3P	EW302996
	U/T	Cord Set U/T (3 cores)	3P	EW302646
Class II	CEE	Cord Set CEE (2 cores)	2P	EW638144
	BEAB	Cord Set BEAB (2 cores)	2P	EW302995
	SAA	Cord Set SAA (2 cores)	2P	EW302991
	U/T	Cord Set U/T (2 cores)	2P	EW302899

1. RECOMMENDED SPARE PARTS LIST

Because, if the parts listed below are on hand, almost any repair can be accomplished, we suggest that you stock these Recommended Spare Parts Items.

Parts No.	Description	Notes
BA325982	Arm Control PCB Comp. AP-Q80	
BA325986	Motor Drive PCB Comp. AP-Q80 (CEE)	CEE, UK, SAA
BA325987	Motor Drive PCB Comp. AP-Q80 (CSA)	CSA, AAL
BA327579	Motor Drive PCB Comp. AP-Q80 (JPN)	JPN
BA325988	Motor Drive PCB Comp. AP-Q80 (U/T)	
BA325983	Synthesizer PCB Comp. AP-Q80	
BM326996	Motor BLK DDM-73D	
BM326962	Motor GA208B01	
BT326972	⚠ Trans Power APT80-10	JPN
BT326973	⚠ Trans Power APT80-30	CSA, AAL
BT326974	⚠ Trans Power APT80-40	U/T, CEE, UK, SAA
EC616342	C S-Fix H CTY122D33 1.5–16	
ED326971	D LED NJL1103E Infrared Ray	
ED318988	D LED SR505D RED	
ED326994	D LED TLG205 GRN	
ED557447	D Silicon H 1S1588	
ED321115	D Silicon H 1S1588LB-5 F10	
ED306724	D Silicon S5277B 100/1.0A	
ED323530	D Zener H 05Z12 U	
ED323211	D Zener H 05Z13 L	
ED326747	IND LED SL-1172-03 Character	
ED326748	IND LED SL-1174-03 Character	
EF300585	⚠ Fuse EAK T 250V 0.80A	U/T, CEE, UK, SAA
EF300590	⚠ Fuse EAWK T 250V 0.40A	U/T, CEE, UK, SAA
EF327103	⚠ Fuse TSC A 250V 0.50A	JPN
EF309388	⚠ Fuse TSC A 250V 0.80A	JPN
EF309391	⚠ Fuse TSC 125V 0.08A	CSA, AAL
EF309390	⚠ Fuse TSC 125V 0.50A	CSA, AAL
EI325557	IC AP-400-A (TM4504P)	
EI326750	IC AP-500-A	
EI326959	IC AP-600-A	
EI326702	IC NJM78M05A	
EI322599	IC TA75458S	
EI313797	IC TC4001BP	
EI304657	IC TC4011BP	
EI306726	IC TC4069UBP	
EI315380	IC TC5012BP	
EI324532	OSC X'TAL 5.400000MC	
EI325556	Photo Sensor NJL514E-A (A) (B) (C)	
EI326742	Terminal Touch 5 Modes Touch Sensor P 5P	

Parts No.	Description	Notes
EI326977	Terminal Touch 9 Modes Touch Sensor P 9P	
EP326960	Relay Signal G2V-282P 2TR 12V	
EP326963	Solenoid AP-Q80	
ES326961	SW Leaf MSW-0026TU 01-1 NO	
ET326969	TR Photo NJL7141E	
ET326958	TR Photo TPS601	
ET326995	TR 2SA659 (E) (F)	
ET306720	TR 2SA966 (O) (Y)	
ET200925	TR 2SA970 GR	
ET307234	TR 2SC1815 (Y) (GR)	
ET325482	TR 2SC1959 (Y)	
ET306719	TR 2SC2236 (O) (Y)	
EV499375	R S-Fix H V10K8-4-2 3P 501	
EV571803	R S-Fix H V10K8-4-2 3P 504	
EV326719	R S-Fix V TM8KH1-1S 3P 0.30W 203	
EV326982	R S-Fix V V10F8-1-2 3P 504	
EV321652	R S-Fix V V10K8-1-2 3P 203	
EV326790	R S-Fix V V10K8-1-2 3P 304	
EW313884	⚠AC Cord 2 Cores GTBS-2F B	UK
EW306428	⚠AC Cord 2 Cores KP-205A, VFF UCJ	U/T
EW306427	⚠AC Cord 2 Cores KP-211, VFF J	JPN
EW313882	⚠AC Cord 2 Cores KP-419C, LTCE-2F E	CEE
EW305691	⚠AC Cord 2 Cores KP-8, SPT-1 UC	CSA, AAL
EW201515	⚠AC Cord 2 Cores KP-560, LTSA-2F S	SAA
EW326739	Cord P-54-076 2P Audio	EXCEPT AAL
EW326738	Cord P-54-077 2P Audio	AAL

2. SYNTHESIZER PCB (APQ-7049) BLOCK

Symbol No.	Parts No.	Description	Schematic No.
2-1	BA325983	Synthesizer PCB Comp. AP-Q80	
2-IC1	EI326750	IC AP-500-A	45-8-444
2-IC2	EI325557	IC AP-400-A (TM4504P)	45-8-435
2-IC3	EI304657	IC TC4011BP	45-8-232
2-IC5,6	EI306726	IC TC4069UBP	45-8-263
2-TR1	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
2-TR3	ET200925	TR 2SA970 GR	45-1-303
2-TR4, 5	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
2-TR6,7	ET325482	TR 2SC1959 (Y)	45-1-385
2-TR8	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
2-TR9to16	ET200925	TR 2SA970 GR	45-1-303
2-TR17to19	ET325482	TR 2SC1959 (Y)	45-1-385
2-D1to6	ED321115	D Silicon H 1S1588LB-5 F10	45-3-62
2-D10	ED321115	D Silicon H 1S1588LB-5 F10	45-3-62
2-VC1	EC616342	C S-Fix H CTY122D331.5–16	24-2-32
2-VR1	EV326982	R S-Fix V V10F8-1-2 3P 504	36-10-255
2-VR3	EV326982	R S-Fix V V10F8-1-2 3P 504	36-10-255
2-L1	EO328137	Coil Fix 2 NI-0036 2.20μH	23-1-396
2-X1	EI324532	OSC X'TAL 5.400000MC	53-1-210

3. MOTOR DRIVE PCB (APQ-7054) BLOCK

Symbol No.	Parts No.	Description	Schematic No.
3-1	BA325988	Motor Drive PCB Comp. AP-Q80 (U/T)	
3-2	BA327579	Motor Drive PCB Comp. AP-Q80 (JPN) (JPN)	
3-3	BA325987	Motor Drive PCB Comp. AP-Q80 (CSA) (CSA, AAL)	
3-4	BA325986	Motor Drive PCB Comp. AP-Q80 (CEE) (CEE, UK, SAA)	
3-IC1,2	EI322599	IC TA75458S	45-8-415
3-IC3,4	EI326702	IC NJM78M05A	45-8-496
3-TR1	ET200925	TR 2SA970 GR	45-1-303
3-TR4	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
3-TR5	ET200925	TR 2SA970 GR	45-1-303
3-TR6	ET306719	TR 2SC2236 (O) (Y)	45-1-307
3-TR7	ET306720	TR 2SA966 (O) (Y)	45-1-306
3-TR8	ET306719	TR 2SC2236 (O) (Y)	45-1-307
3-TR9	ET306720	TR 2SA966 (O) (Y)	45-1-306
3-TR10	ET306719	TR 2SC2236 (O) (Y)	45-1-307
3-TR11	ET306720	TR 2SA966 (O) (Y)	45-1-306
3-D4	ED323530	D Zener H 05Z12 U	45-6-76
3-D5	ED323211	D Zener H 05Z13 L	45-6-76
3-D6to13	ED306724	Silicon S5277B 100/1.0A	45-2-79
3-D14	ED321115	D Silicon H 1S1588L B-5 F10	45-3-62
3-D15	ED324194	D Zener 05Z5.1 L	45-6-76
3-D16,17	ED306724	D Silicon S5277B 100/1.0A	45-2-79
3-D18	ED321115	D Silicon H 1S1588LB-5 F10	45-3-62
3-D19	ED557447	D Silicon H 1S1588	45-3-22
3-VR1,2	EV321652	R S-Fix V V10K8-1-2 3P 203	36-10-255
3-VR3	EV326790	R S-Fix V V10K8-1-2 3P 304	36-10-255
3-VR4	EV326719	R S-Fix V TM8KH1-1S 3P 0.30W 203	36-28-11
3-R35	ER536984	⚠R CB H RD 1/2W 4R7J	35-9-9
3-C1,2	EC326788	C SA V F05 1R5M 16.0DC	24-19-3
3-C12,13	EC316184	C EC V CUT H 102M 25.0 DC	24-12-46
3-C19	EC320548	⚠C CE V F 103Z 250AC (U/T, JPN)	24-5-112
3-C19	EC314688	⚠C CE V FZ 103P 125AC (CSA, AAL)	24-5-87
3-C19	EC325671	⚠C MP V 103M 250AC (CEE, UK, SAA)	24-9-134

4. ARM CONTROL PCB (APQ-8045) BLOCK

Symbol No.	Parts No.	Description	Schematic No.
4-1	BA325982	Arm Control PCB Comp. AP-Q80	
4-IC1	EI326959	IC AP-600-A	45-8-483
4-IC2,3	EI315380	IC TC5012BP	45-8-356
4-IC4,5	EI306726	IC TC4069UBP	45-8-263
4-IC6,7	EI313797	IC TC4001BP	45-8-348
4-IC8,9	EI304657	IC TC4011BP	45-8-232
4-TR1to3	ET200925	TR 2SA970 GR	45-1-303
4-TR4	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
4-TR5	ET325482	TR 2SC1959 (Y)	45-1-385
4-TR6	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
4-TR7	ET325482	TR 2SC1959 (Y)	45-1-385
4-TR8	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
4-TR9	ET325482	TR 2SC1959 (Y)	45-1-385
4-TR10to16	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
4-TR17	ET326995	TR 2SA659 (E) (F)	45-1-393
4-TR18	ET200925	TR 2SA970 GR	45-1-303
4-TR19to23	ET307234	TR 2SC1815(Y) (GR)	45-1-299
4-TR24	ET325482	TR 2SC1959 (Y)	45-1-385
4-TR25	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
4-D1to9	ED321115	D Silicon H 1S1588LB-5 F10	45-3-62
4-D10to12	ED306724	D Silicon S5277B 100/1.0A	45-2-79
4-D13,14	ED321115	D Silicon H 1S1588LB-5 F10	45-3-62
4-D15	ED306724	D Silicon S5277B 100/1.0A	45-2-79
4-VR1	EV571803	R S-Fix H V10K8-4-2 3P 504	36-10-250
4-VR2	EV326982	R S-Fix V V10F8-1-2 3P 504	36-10-255
4-VR3	EV326790	R S-Fix V V10K8-1-2 3P 304	36-10-255
4-VR4,5	EV326982	R S-Fix V V10F8-1-2 3P 504	36-10-255
4-VR6,7	EV499375	R S-Fix H V10K8-4-2 3P 501	36-10-250
4-T1	BT293398	Coil IFT RMC-42246BCH 468.0KC	23-1-276
4-RL1	EP326960	Relay Signal G2V-282P 2TR 12V	47-2-37
4-C15	EC326984	C EC V F05 NP 04D 470M 50.0DC	24-17-31
4-C31,32	EC326998	C SA V F05 R15M 25.0DC	24-19-3

5. SIZE SENSOR PCB (APQ-8044) BLOCK

Symbol No.	Parts No.	Description	Schematic No.
5-TR1to3	ET326969	TR Photo NJL7141E	45-1-388
5-D1to3	ED326971	D LED NJL1103E Infrared Ray	45-15-44

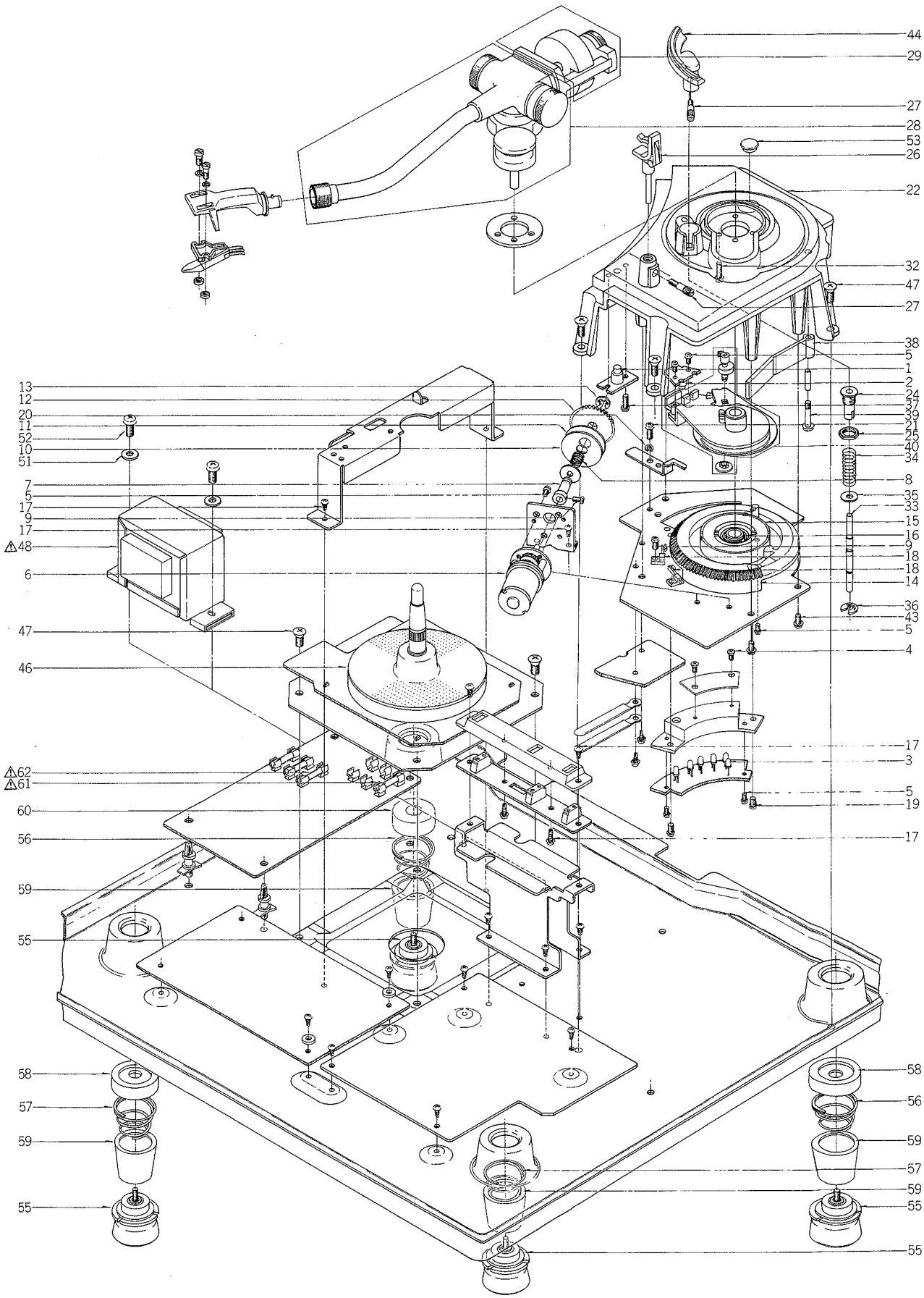
6. SIZE DETECTION PCB (APQ-8048) BLOCK

Symbol No.	Parts No.	Description	Schematic No.
6-TR1	ET200925	TR 2SA970 GR	45-1-303
6-TR2	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
6-TR3	ET200925	TR 2SA970 GR	45-1-303
6-TR4	ET307234	TR 2SC1815 (Y) (GR)	45-1-299
6-D1	ED303155	D Zener 05Z5.6 U	45-6-76
6-D3	ED303155	D Zener 05Z5.6 U	45-6-76

7. SIZE SENSOR CONTROL PCB (APQ-8052) BLOCK

Symbol No.	Parts No.	Description	Schematic No.
7-IC1,2	EI313797	IC TC4001BP	45-8-348

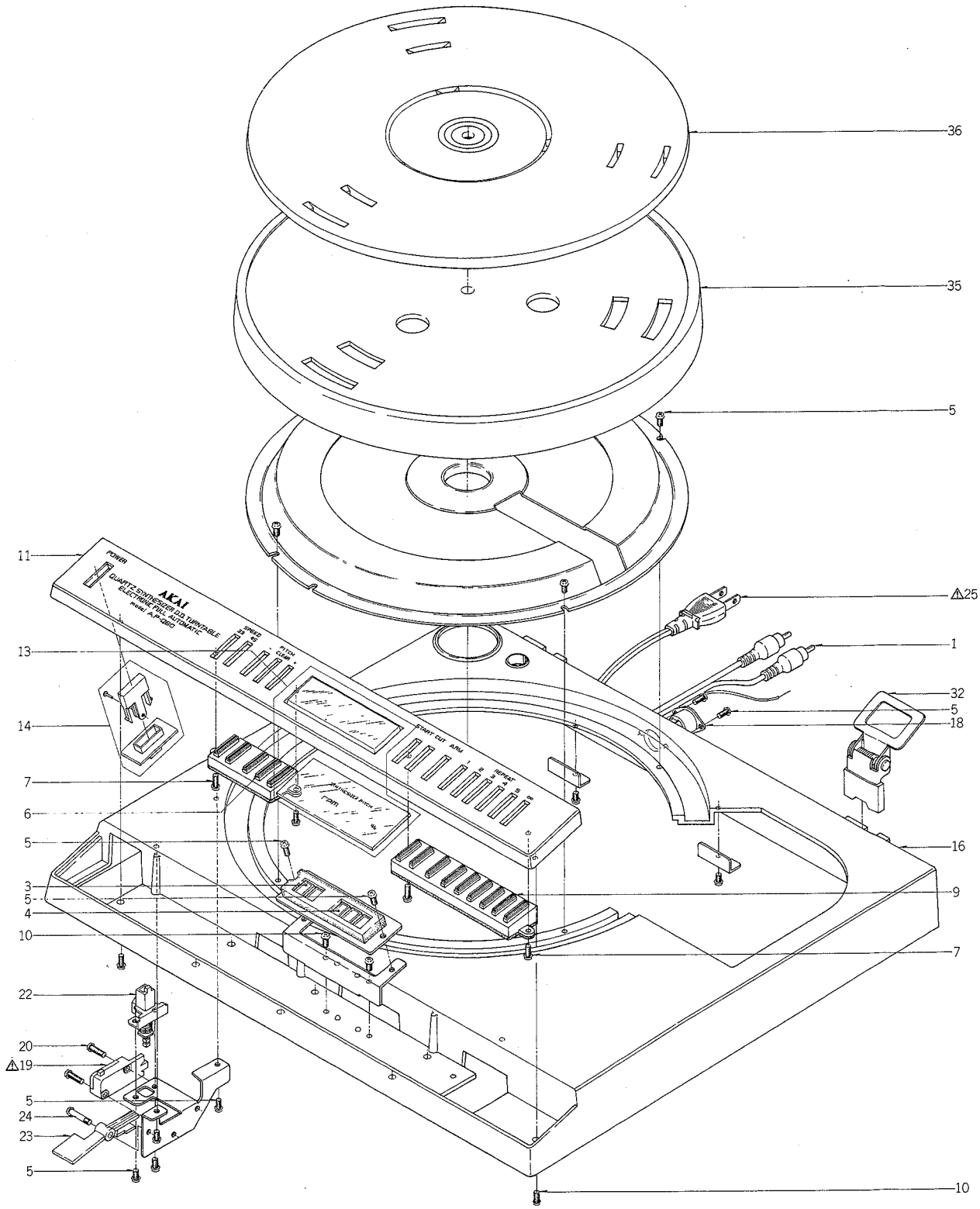
8. ASSEMBLY BLOCK (1)



ASSEMBLY BLOCK (1)

Ref. No.	Parts No.	Description	Schematic No.
FG SENSOR PCB BLK			
8-1	EI325556	Photo Sensor NJL5141E-A (A) (B) (C)	45-18-3
PHOTO TR PCB BLK			
8-2	ET326958	TR Photo TPS601	45-1-387
LED (B) BLK			
8-3	ED318988	D LED SR505D RED	45-15-51
8-4	ZS321851	CTS20X05STL CMT	
8-5	ZS608095	PAN20X05STL CMT	
MOTOR BLK			
8-6	BM326962	Motor GA208B01	9-2-46
8-7	TP326917	Motor Metal	APQ-8018
8-8	ZG313224	SP C-6.5/1.0-10.0 C-069	
8-9	ZS479474	PAN26X05STL CMT	
8-10	TP326918	Coupling Plate	APQ-8019
8-11	TP326919	Coupling Cloth	APQ-8020
8-12	TP326920	Motor Gear	APQ-8021
8-13	ZW270123	RingE400SUP CMT	6-1-9
AUTO CHASSIS BLK			
8-14	TP326911	Operation Gear	APQ-8012
8-15	EP326963	Solenoid AP-Q80	44-1-135
8-16	ZW326997	RingBG110	6-1-17
8-17	ZS325495	T2BR30X06STL CMT	
8-18	ES326961	SW Leaf MSW-0026TU 01-1 NO	25-10-43
8-19	ZS477887	CTS26X05STL CMT	
8-20	ZW273745	SW30	
8-21	ZS302945	ST PAN30X08STL BNI	
ARM BASE BLK			
8-22	TP326651	Arm Base	APQ-7001
8-23X	TP326652	Arm Base (BL)	APQ-7001
8-24	TP326654	Lifter Guide (B)	APQ-7002
8-25	ZW326792	N80STL CMT P075	
8-26	TP326662	Arm Rest Part	APQ-7010
8-27	ZS326688	Decoration Screw	APQ-7039
8-28	TP325969	Tone Arm Part AP-Q70	53-1-191
8-29	TP326736	Weight	53-1-199
8-30X	TP325970	Tone Arm (BL) Part AP-Q70-BL	53-1-195
8-31X	TP326737	Weight (BL)	53-1-200
8-32	ZS325503	PLX PAN30X12STL CMT	7-1-70
8-33	TP326900	Lifter Shaft	APQ-8001
8-34	ZG326901	Lifter Spring	APQ-8002
8-35	ZW292770	PW41X100X050STL CMT	
8-36	ZW290283	RingU285SUP CMT	6-1-1
8-37	ZS326789	ST PAN30X06STL BNI	
8-38	TP326921	Brake Plate	APQ-8022
8-39	ZS302767	Shaft Screw	AP-0074
8-40	TP325997	PU Plate ASSY AP-Q80	APQ-8003
8-41X	ZG326907	Clutch Spring	APQ-8008
8-42X	ZG317496	Felt Tension Spring	MR-260
8-43	ZS5581C1	PAN30X06STL CMT TW	
8-44	TP326440	Lifter Part AP-Q70	APQ-7004
8-45X	EO669273	Coil Fix 2 FL5R200 18.00UH	23-1-248
8-46	BM326996	Motor BLK DDM-73D	9-2-48
8-47	ZS427026	CTS40X10STL CMT	
ASSEMBLY BLK			
8-48	BT326974	⚠Trans Power APT80-40 (U/T, CEE, UK, SAA)	38-4-843
8-49X	BT326972	⚠Trans Power APT80-10 (JPN)	38-4-841
8-50X	BT326973	⚠Trans Power APT80-30 (CSA, AAL)	38-4-842
8-51	ZW237857	PW41X100X100STL CMT	
8-52	ZS424056	PAN40X10STL CMT	
8-53	TP302504	Rubber Bush	AP-0043
8-54X	ZW556830	PW31X080X100STL BNI	
8-55	TP326723	Insulator Part	3-18-27
8-56	ZG326683	Float Spring (A)	APQ-7036
8-57	ZG326684	Float Spring (B)	APQ-7036
8-58	TP326690	Damper (A)	APQ-7044
8-59	TP326691	Damper (B)	APQ-7045
8-60	TP326692	Damper (C)	APQ-7046
8-61	EF300590	⚠Fuse EAWK T 250V 0.40A (U/T, CEE, UK, SAA)	39-1-60
8-62	EF300585	⚠Fuse EAK T 250V 0.80A (U/T, CEE, UK, SAA)	39-1-59
8-63X	EF327103	⚠Fuse TSC A 250V 0.50A (JPN)	39-1-64
8-64X	EF309388	⚠Fuse TSC A 250V 0.80A (JPN)	39-1-64
8-65X	EF309390	⚠Fuse TSC 125V 0.50V (CSA,AAL)	39-1-65
8-66X	EF309391	⚠Fuse TSC 125V 0.08V (CSA,AAL)	39-1-65

9. ASSEMBLY BLOCK (2)



ASSEMBLY BLOCK (2)

Ref. No.	Parts No.	Description	Schematic No.
RELAY PCB BLK			
9-1	EW326739	Cord P-54-076 2P Audio (Except AAL)	26-10-24
9-2X	EW326738	Cord P-54-077 2P Audio (AAL)	26-10-23
LED PCB BLK			
9-3	ED326747	IND LED SL-1172-03 CHARACTER	59-2-4
9-4	ED326748	IND LED SL-1174-03 CHARACTER	59-2-5
9-5	ZS326789	ST PAN30X06STL BNI	
TOUCH SW PCB (A) BLK			
9-6	EI326742	Terminal Touch 5 Modes Touch Sensor P 5P	25-13-2
9-7	ZS447840	T2BR30X08STL CMT	
TOUCH SW PCB (C) BLK			
9-8X	ED326994	D LED TLG205 GRN	45-15-48
9-9	EI326977	Terminal Touch 9 Modes Touch Sensor P 9P	25-13-3
OP PANEL BLK			
9-10	ZS302945	ST PAN30X08STL BNI	
9-11	SP326922	Operation Panel AP-Q80	APQ-8024
9-12X	SP326923	Operation Panel AP-Q80-BL	APQ-8024
9-13	TP326497	Window Part AP-Q70	APQ-7018
9-14	SB326498	Button Part AP-Q70	APQ-7024
9-15X	SB326499	Button (BL) Part AP-Q70-BL	APQ-7024
CABINET BLK			
9-16	BC326975	Cabinet AP-Q80	1-35-3
9-17X	BC326976	Cabinet AP-Q80-BL	1-35-4
9-18	EJ324119	Din J TCS1080-01-101 L 8P	31-1-255
ASSEMBLY BLK			
9-19	ES316432	⚠SW Micro K2 EUC	25-1-59
9-20	ZS419670	PAN30X12STL CMT (U/T, JPN, CSA, AAL)	
9-21X	ZS302778	PAN30X15PCN (CEE, UK, SAA)	
9-22	ES326746	SW Push SUF12AK3 2-02-02	25-5-366
9-23	ML326677	Power SW. Lever	APQ-7030
9-24	ZS302767	Shaft Screw	AP-0074
9-24	ZS302767	Shaft Screw	AP-0074
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Parts No.	Ref. No. & Symbol No.	Parts No.	Ref. No. & Symbol No.	Parts No.	Ref. No. & Symbol No.	Parts No.	Ref. No. & Symbol No.	Parts No.	Ref. No. & Symbol No.
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SECTION 3

SCHEMATIC DIAGRAM

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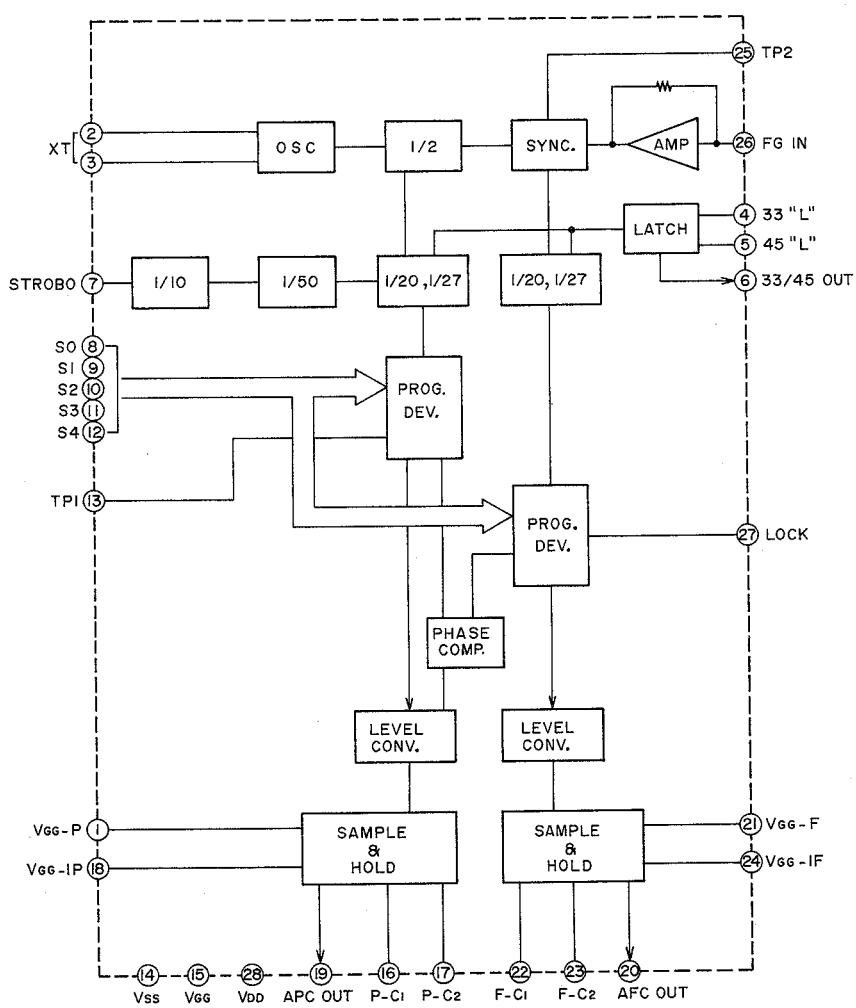
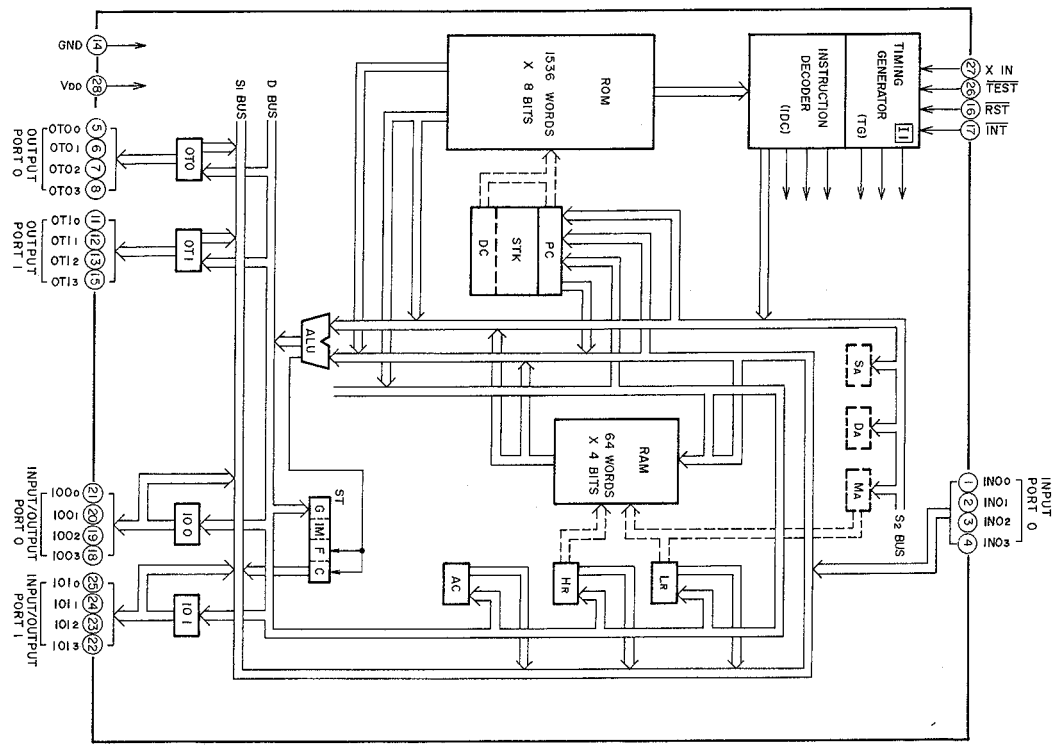
AP400A



AP500A



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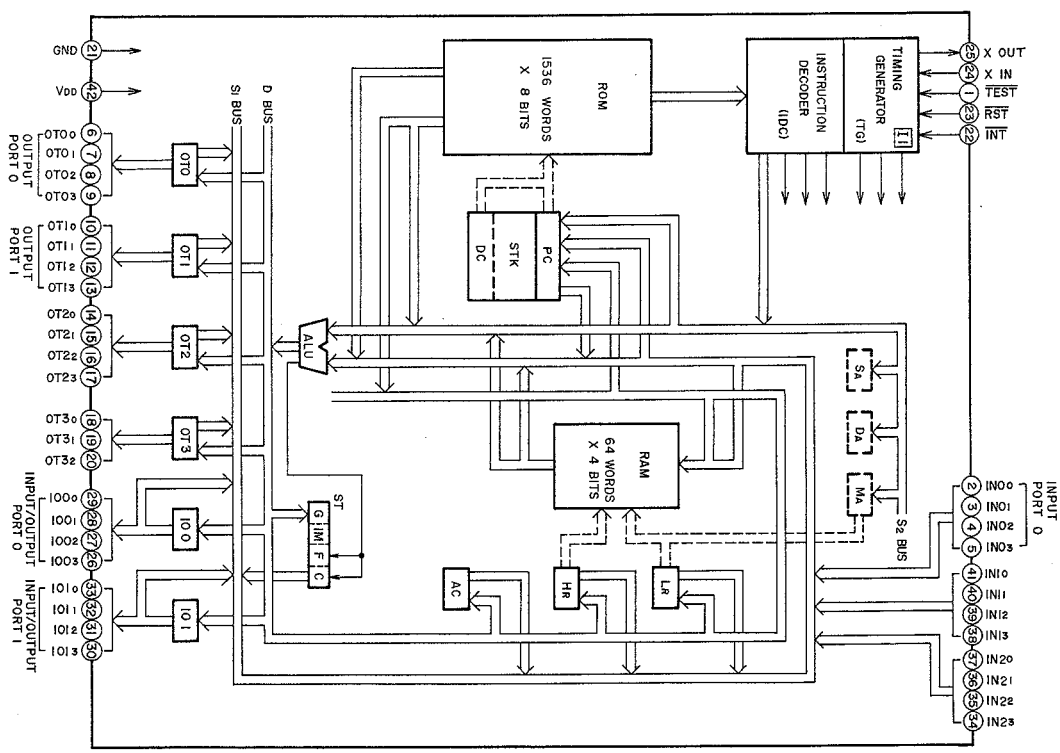

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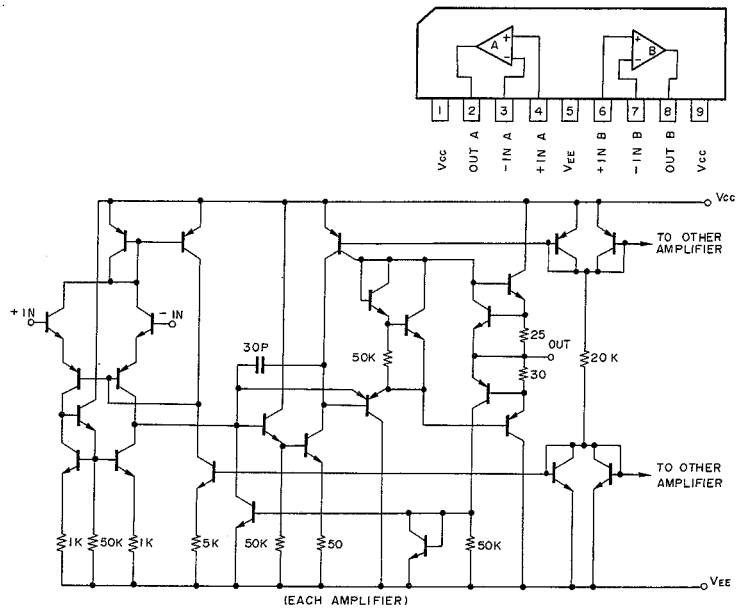

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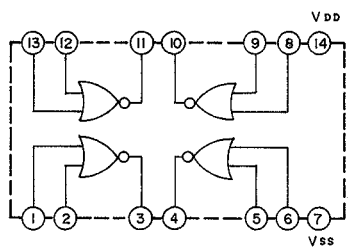

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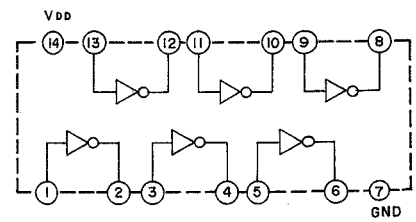

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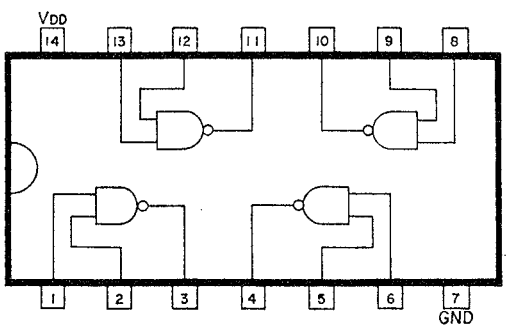
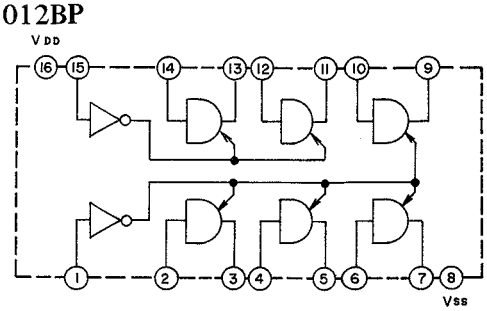


TC5012BP



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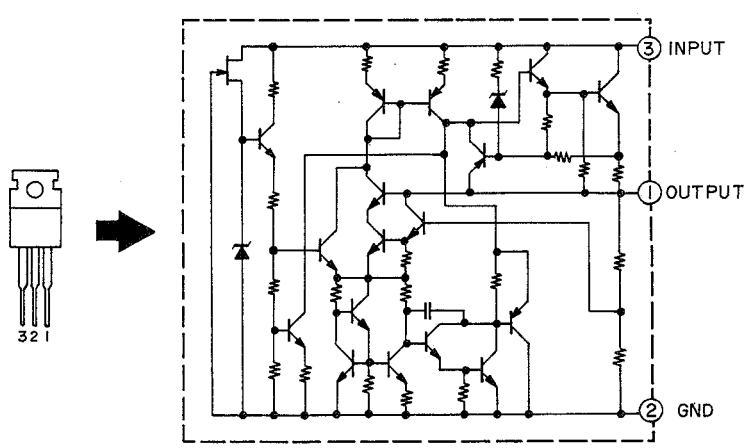
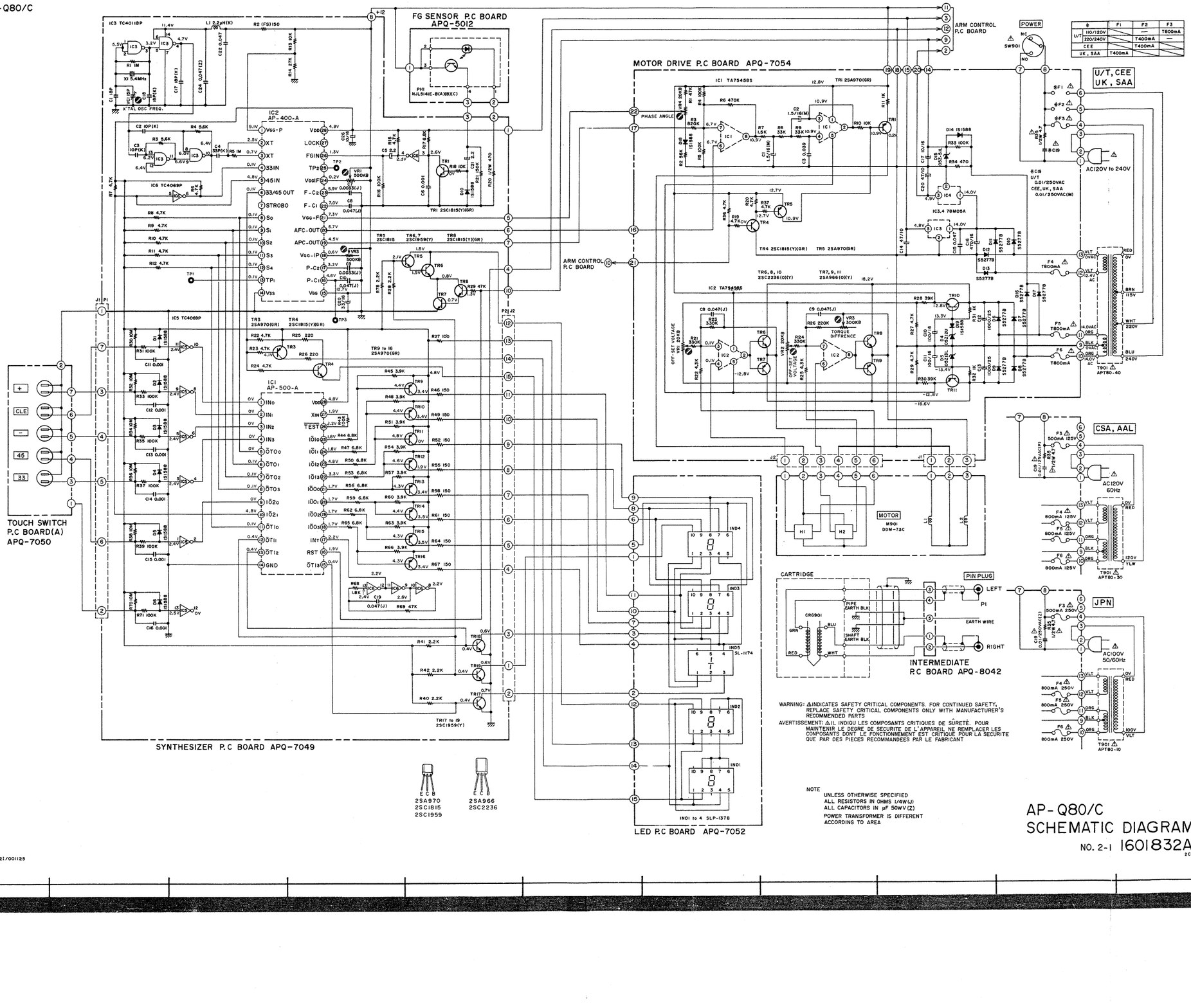


AP-Q80/C



⊕	F1	F2	F3
U/T 110/120V		—	T800mA
U/T 220/240V		T400mA	—
CEE		T400mA	
UK, SAA	T400mA		

WARNING: ⚠INDICATES SAFETY CRITICAL COMPONENTS. FOR CONTINUED SAFETY, REPLACE SAFETY CRITICAL COMPONENTS ONLY WITH MANUFACTURER'S RECOMMENDED PARTS

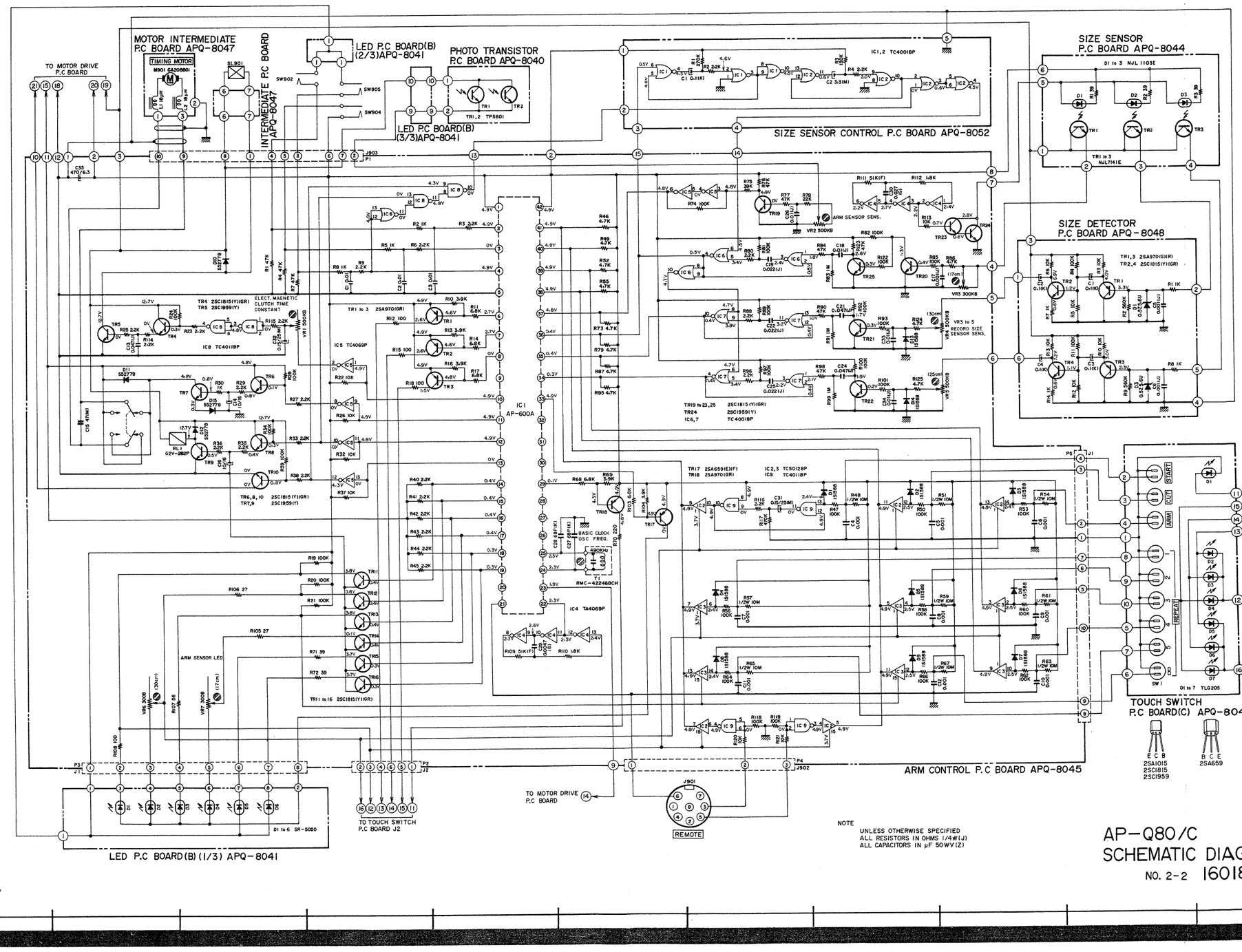
AVERTISSEMENT: ⚠IL INDIQU LES COMPOSANTS CRITIQUES DE SÛRETÉ. POUR MAINTENIR LE DEGRÉ DE SECURITE DE L'APPAREIL NE REMPLACER LES COMPOSANTS DONT LE FONCTIONNEMENT EST CRITIQUE POUR LA SECURITE QUE PAR DES PIECES RECOMMANDEES PAR LE FABRICANT

NOTE
UNLESS OTHERWISE SPECIFIED
ALL RESISTORS IN OHMS 1/4W(J)
ALL CAPACITORS IN μF 50WV(Z)
POWER TRANSFORMER IS DIFFERENT ACCORDING TO AREA

AP-Q80/C
SCHEMATIC DIAGRAM
NO. 2-1 1601832A 2C

0011221/001125

AP-Q80/C



NOTE
UNLESS OTHERWISE SPECIFIED
ALL RESISTORS IN OHMS 1/4W(J)
ALL CAPACITORS IN μF 50WV(Z)

AP-Q80/C SCHEMATIC DIAGRAM

NO. 2-2 1601833A 2C

001123F